THE RAILROAD AND
ENGINEERING JOURNAL.

(ESTABLISHED IN 1832.)

THE OLDEST RAILROAD PAPER IN THE WORLD.

PUBLISHED MONTHLY AT NO. 47 CEDAR STREET, NEW YORK.

M. N. FORNEY, ... Editor and Proprietor.
FREDERICK HOBART. . . . . Associate Editor.

Entered at the Post Office at New York City as Second-Class Mail Matter.

SUBSCRIPTION RATES.

Subscription, per annum, Postage prepaid.....$3 00
Subscription, per annum, Foreign Countries..... 3 50
Single copies..... 25

Remittances should be made by Express Money-Order, Draft, P. O. Money-Order or Registered Letter.

NEW YORK, MAY, 1892.

SOME copies of the number of the RAILROAD AND ENGINEERING JOURNAL for June, 1888, are needed to complete our files. Any subscriber having a copy of that number which he does not wish to preserve will confer a favor on the publishers if he will send it to this office. For every such copy received a credit of *three* months on his subscription will be given to the sender.

THE House of Representatives has approved the report of the Naval Committee, which recommended that only one new ship should be authorized this year—an armored cruiser of the same class as the *New York*. It is understood that the Senate will amend the bill to provide for two more battle-ships in addition; but the disposition of the House seems to be to adhere to its recent action.

SOME valuable historical exhibits are promised for the Chicago Exposition, and if the plans announced are carried out, there will be an opportunity to study the development of railroad construction and machinery such as has never before been presented. There is now no doubt that the Department of Transportation will be one of the most interesting sections of the Exposition.

AN interesting feature of recent marine development is the revival of the sailing ship, which seems to be taking place, in spite of the reduction in cost of operating steamships. Some very large sailing vessels have lately been built, and have proved themselves very successful carriers. Some of them are provided with auxiliary engines for use in case of need; but even with these the sails are the main reliance, and the engines are entirely subordinate. For long voyages especially the sailing ship is still an important factor in commerce, and is likely to hold its place for a good many years to come as a carrier of heavy freight.

A BILL to authorize the use of electricity instead of steam for motive power on railroads is before the Massachusetts Legislature; and some of the railroad managers of that State are reported as prophesying that the change will be made in a few years. Some of these utterances seem to be too sanguine, when we consider that no motor has yet been shown capable of hauling heavy trains at a high speed over long distances. It is dangerous to predict too much in these days, however; and, in view of what has already been done, it seems altogether probable that such a motor may be invented and set at work within a few years.

THE New York Central & Hudson River Railroad Company has just completed a new draw-span in its bridge over the Harlem River at One Hundred and Thirty-fourth Street, New York, which is of peculiar construction. It is a lifting bridge—not a swing bridge—is double tracked, and is 93 ft. long. The tower which carries the lifting arrangement is 120 ft. in height. The bridge is raised by a double-cylinder hoisting engine, and there are two counterbalance weights of 45 tons each. The bridge can be raised or lowered in 20 seconds.

The new draw is immediately south of the old swinging draw-span. All the work upon it has been done without interrupting the passage of trains—a difficulty which will be appreciated when it is stated that some 300 regular trains a day pass over the bridge, besides all the switching trains to and from the Mott Haven yard.

THE very sensible suggestion is made that there should be at the Columbian Exposition a concentration of the exhibits of road machinery and material, and of all that relates to construction and maintenance of roads. Under the classification at present adopted, these exhibits will be divided up among the Transportation, Machinery, Manufactures, Mining and Agricultural buildings, and so scattered that the effect will be lost, and it will take time and trouble, even for one interested, to find it all.

The road question is one of very great importance, reaching almost every one of us either directly or indirectly, and the road exhibits ought to have a better place. The Exposition will give an opportunity for lessons in road making which ought not to be lost, but should be improved in every way possible.

NEW railroad building is not very active as yet, and, so far as it is possible to predict, it does not seem probable that the new track laid in 1892 will much exceed that of 1891. Long lists of new railroads in progress have been published, but most of them have not yet reached the stage of actual construction work, and are merely projected. Some have gone as far as preliminary surveys or final location, but the number on which actual grading or tracklaying has been begun is comparatively few. There is some difficulty in raising money for new enterprises still; and the chances for any railroad "boom" this year are not great.

WHILE new building is somewhat slow, the demand for railroad equipment is active, and numerous orders for locomotives and cars are reported. The railroads generally seem to be increasing their rolling stock, as well as filling up the gaps made by the depreciation of the past two or three years when renewals have been postponed.

In the new orders for motive power there seems to be a notable increase in the number of locomotives built for suburban and other special service. This was to be expected from the increasing complexity of railroad business and the greater variety of special service required.

THE great bridge over the Mississippi at Memphis was to be opened for traffic on May 1 with appropriate ceremonies. It is a notable structure in itself, and is notable also as being the first bridge crossing the Mississippi below St. Louis. In some respects the conditions at Memphis were favorable to the building of a bridge, but in other respects they were not, and some serious problems were met and successfully solved by the engineers.

The Memphis bridge will probably remain the lowest bridge crossing of the river for some time to come. There has been some talk of a bridge at New Orleans, but it has not assumed definite shape as yet, and the difficulties in the way are very great.

THE Poughkeepsie Bridge over the Hudson, while it is an admirable structure from an engineering point of view, has not been a commercial success, and has not earned enough to pay interest on its bonds. This is largely due to the fact that it has had no good connections, and has been used only by one line of small traffic. The present prospect is that it will pass under the control of the Reading combination, and in that case its business may be largely increased, as a very considerable coal traffic may be carried over it.

THE building of the proposed light-house on the Outer Diamond Shoal, off Cape Hatteras, has been abandoned for the present, the contractors having given up the work owing to the difficulties caused by the shifting nature of the bottom and the changes which have occurred since the last surveys were made. Messrs. Anderson & Barr have constructed many difficult foundations, but they do not believe that this work can be carried through successfully under the conditions required.

IN his annual address to the American Railway Association, a portion of which is given on another page, President Haines makes a plea against compulsory legislation for the adoption of safety appliances, his argument being especially addressed to the case of automatic couplers. Mr. Haines bases his argument chiefly upon what has already been done by the Master Car-Builders' Association and by the Association over which he presides, and makes the claim that the adoption of a safety coupler has been accomplished, and that it is being brought into use as fast as circumstances will permit. He believes the best solution of the question is in the voluntary action of the railroad companies, and thinks that this will, in the course of the next two or three years, make legislation unnecessary.

In this address Mr. Haines has taken the only ground upon which opposition to compulsory legislation can be successfully conducted. If the railroad companies support the action of their representatives and show a disposition to carry their resolutions into effect, his argument will be effective; and such action on their part is the true and practical way to avert the passage of a law which they do not want.

THE bills providing for the adoption of a safety coupler are to be postponed for the present, if committee action is to be considered as any indication. Recently the Senate Committee having the bills in charge reported an amendment to the Interstate Commerce Law directing the Commissioners to collect information as to the number of automatic couplers in use and their pattern, the number brought into use during the year and other statistics bearing on this point. The information so gathered is to be reported to Congress, and will serve as the basis for future action. It is evident that the Committee believes more information to be necessary before Congress can properly decide on the question.

ONE of the features of the railroad exhibit at the Columbian Exhibition will be a historical collection of railroad tickets. The work of collecting and arranging this has been undertaken by Mr. George De Haven, the General Passenger Agent of the Chicago & West Michigan Railroad, who has given much attention to this subject in the past, and has already many valuable data. He invites correspondence with all interested in the subject, and will take care that any collections, documents, etc., loaned for the Exhibition will be carefully handled, preserved, and returned at its close.

THROUGH the efforts of a committee, of which Mr. William Toothe was Chairman, the Railroad Supply Men, to be in fashion with the other business interests, had a dinner at Delmonico's on Friday evening, April 22.

It was quite a notable gathering, and was presided over by General E. S. Greeley, as representative of the longest service in the supply trade.

The after-dinner speeches were entirely informal; following instructions from the Chair, they kept as far from the toasts assigned them as they could. Among those who spoke were Mr. J. B. Ecclesine, Colonel Green, Captain Tarr, Mr. David Dodd, Mr. Angus Sinclair and others. Colonel C. A. Moore very happily presented the hopes and desires of the promoters of the dinner, as an effort to bring into closer and pleasanter social relations those who in business were seeking the same lines of trade, believing that while "business was business," there was room for a little sentiment, and that a closer social life would not only make business relations pleasanter, but make life better worth living.

His remarks were so kindly received, that it was unanimously voted that Mr. Greeley should be Chairman, and appoint a committee to secure a permanent organization of the interests represented.

The guests were very delightfully entertained by Mrs. Sherwood in her inimitable whistling and by Mr. E. J. Bushnell in several songs. The occasion was altogether one to be remembered by those present with pleasure, and with a wish that it may not be the last of its kind.

THE USES OF ALUMINUM.

LIKE every new question, that of the use of aluminum has had to pass through various phases of discussion. In the first place, its value was greatly exaggerated, and we were assured that it was the "metal of the future," which was to supersede iron, steel, and brass for all constructive purposes. More recently the natural reaction has followed, and we have been told that, after all, the metal was of very little account for practical purposes. In this, as in the first case, writers who have sought to instruct the public have gone much too far.

The truth appears to lie between the two extremes. The great advantages of aluminum in its lightness, ease

of working, and some other qualities will give it a certain and important place, but its behavior under compressive and transverse strains is hardly such as to make it such an efficient substitute for steel in construction as has been claimed in some quarters.

Probably the greatest use of aluminum will be found in alloys with other metals. In combinations such as aluminum bronze and others it is giving us some valuable additions to our available metals, and much is hoped for from its use in small quantities with steel and iron. The experiments already made in this direction have accomplished much, and show that more is to be hoped for.

The high price of the metal has hitherto prevented its free use, but considerable reductions in this direction may be expected. No less an authority than Mr. Hunt, who has been one of the pioneers in the manufacture, assures us that a gradual reduction in price is probable as methods of reduction are improved; but the full force of this will not be felt until the output and demand are expressed in tons, instead of pounds, as at present.

FAST TRAINS.

MUCH public attention has recently been given both in this country and abroad to the question of fast time on railroads. There has been considerable rivalry among railroad companies in running fast trains, and the question has been discussed at length in the public prints, both technical and popular. Comparisons have been made between the railroads of different countries, and claims of all sorts have been made for superiority in this respect by writers of different nationalities.

What the public is chiefly interested in, however, is what may be called the commercial speed of trains—that is, the time which a train makes between its terminal points. The average traveler who goes from Chicago to New York, for instance, cares very little, after all, when he is told that at certain points of the run the train on which he travels makes 60 miles an hour; he is chiefly interested in knowing whether it will take him 20, 24, or 30 hours to reach his destination. The commercial speed is the point which will determine his choice of route.

This commercial speed may be increased either by increasing the actual speed or by omitting stops and shortening up delays. The latter is, in fact, the method most usual on long lines, and the extent to which it can be carried depends entirely upon the nature of the business, the amount of the through traffic, and the number of important stations between the terminal points. On a line like that between New York and Philadelphia, for instance, the number of through passengers is sufficient to support the through trains without assistance from the local business; and there, accordingly, the greatest speed and the greatest number of fast trains are to be found.

The fast train question is, after all, chiefly a commercial one. The cost of running is the main point with a railroad company, and if high speed will attract business and bring in a satisfactory return it will be furnished. On those roads where the increase of the commercial speed pays, it will be increased with perhaps a very few exceptions, where an undue conservatism and the absence of competition combine to delay improvements; but, as a rule, it may be said that whenever and wherever the traveling public is numerous and is willing to pay for 60 miles an hour or more, it will be carried at that speed.

CITY TRAFFIC.

THE question of handling traffic in cities is one of the most difficult and perplexing of those which the modern engineer has to answer. The tendency of the present is to concentration of population, and the rapid growth of our large cities leads to demands everywhere for better facilities for movement, which must be met. New York has had this question before it for years, and so far it has met with only a partial solution; much the same may be said of Brooklyn; Philadelphia has begun to discuss it; Boston has reached the point of complete congestion of the existing surface lines; and Chicago is trying to act under the spur, not only of the ordinary demands of the city, but also of the pressing necessity of providing some means for carrying the great number of people who are expected to visit the city next year at the time of the Exposition.

It must be confessed that what has been done so far is not at all a satisfactory solution of the question. Unfortunately a city is not made to order; it grows up gradually, and by the time it is large enough to need some form of rapid transit there are many obstructions in the way. Vested interests in valuable property are to be considered, streets must not be obstructed, and a great variety of other considerations must be taken into account. New York is in most respects very favorably situated for the construction of rapid transit lines, and its elevated roads seemed for a time to serve its needs; but in a few years they began to be considered insufficient, and the continued discussions and efforts to secure a better system are well known.

With all the improvements promised by cable and electric traction, the speed on surface street lines must necessarily be limited to such a degree as to make them unsuited for long distances and to confine them to a limited radius. That the road which is to serve a large city must be above or below the surface is generally admitted. The expense of construction, and to some extent popular prejudice, are against the underground line; while, on the other hand, the interference with the streets, the obstruction of light and air and the damage to adjoining property are the objections likely to be raised to all elevated structures.

It is a case where no general rules can be laid down, and where the engineer must take each one by itself and meet as best he may the difficulties arising. They are sure to be great and to require his best efforts to overcome them. The actual construction will be, in most cases, the least difficult part of the problem; the preliminary work and the overcoming of objections will be the serious part of the work. Probably in a majority of cases the solution will be unsatisfactory to the engineer; for he will not be able to secure the best, but will have to be satisfied with such a compromise as contending interests and circumstances will permit.

There is another problem to which very little attention has yet been given, and that is the quick and economical handling and distribution of freight in cities. Our present methods of collecting and delivering freight are primitive enough, and are hardly an improvement over those of a century ago. Terminal improvements have been confined to the handling of freight at the railroad station; the getting it to and from that point has been left apparently with very little consideration. Especially with small shipments, the delivery at the station in New York, for instance, may cost quite as much as the transportation to

Chicago, and may require more trouble, if not more time.

The passenger question has been so much more pressing that it has absorbed attention heretofore; but freight distribution much needs improvement and must receive it in time. This is a field open to engineers, and those who succeed in occupying it may be sure of a reward.

PRACTICAL RAILROAD INFORMATION.

As the series of articles on Practical Railroad Information, which, we have reason to believe, has been very acceptable to many of our readers, is now drawing to a close, it has been considered best to add another series, which will supplement and complete the first, and will present much that is new and interesting both to railroad officers and manufacturers.

It is well known that there is oft-times a great discrepancy between the results obtained from different chemists' work on the same sample, and the lack of some standard method that can be used to harmonize results obtained by different chemists is a very real difficulty. It has been hoped for a period of years by the chemists engaged in commercial work, if we are rightly informed, that some of the learned societies would recommend standard methods. This want is very great in the steel trade, and also is a constantly growing one in the cases of other manufactured products. The different results obtained by different chemists are believed to be, in large part at least, due to the chemical method. Of course bad manipulation or working on samples which differ, or the use of impure chemicals, may contribute to the uncertainty between chemists, but it is generally believed that the method is the most important of the variables.

In view of this state of affairs, and also in view of the failure of all the chemical societies to recommend standard methods, we have made an arrangement with Dr. C. B. Dudley and F. N. Pease, Chemist and Assistant Chemist of the Pennsylvania Railroad, and authors of the series of articles above referred to, for a complete *exposé* of the methods in use in the laboratory of that corporation. These will give in detail the methods exactly as they are used, so that any one possessing ordinary chemical knowledge will be able to use the method as it is used in the Pennsylvania Railroad Laboratory.

We understand from these chemists that they expect to make these methods part of the contracts on which the materials examined by them are to be purchased, so that in reality these will be in the commercial world, to a certain extent at least, standard methods. Other chemists who are called in to decide disputes will necessarily use the same methods, since they will be part of the contract on which the materials were furnished. It will, of course, be understood that these chemists do not claim that the method which they use and publish is the best one, or the only accurate one, or even the most accurate one, but simply the best that they can recommend at the present time; and they will only serve as standard, if we understand them rightly, until such modifications are made as may be suggested by other chemists, or by their own studies, and may prove themselves as giving better results.

If we are rightly informed, some of the standard methods now in use in agricultural experiment stations started much in this way; and there is little doubt that the printing of the methods above referred to will call a good deal of attention to the matter, notably in the case of those used in the analysis of steel. The first article will probably appear in the June number, and will be followed each month by an installment embracing about three pages of the JOURNAL. It is probable that the methods used in analyzing will appear first.

We understand that the two chemists above named are considerably encouraged to undertake this work by correspondence with a number of the leading commercial chemists in the country, and that they do it with a good deal of hesitancy, but are rather forced to it by the emergency in which they find themselves placed. They entirely disclaim any attempt to arrogate to themselves superior knowledge, or to force themselves into a position of prominence. The scheme is based entirely on the commercial necessities of the case, which have long been recognized.

NEW PUBLICATIONS.

HOW TO BECOME AN ENGINEER. By George W. Plympton. Science Series, No. 100. The D. Van Nostrand Company, New York; price 50 cents.

In this book an attempt has been made to define the term "Engineer," and the author's definition is a sufficiently comprehensive one, for he says: "Engineering is the science of employing the physical properties of matter to serve the purposes of mankind. It includes also the useful application of the different forms of Energy."

The main object, however, is to advise the student who intends to become an engineer how to make the best use of his time and to direct his efforts to the best advantage. To this end a sketch is given of the courses of various technical schools both in this country and abroad. The expressed opinions of several eminent engineers are also quoted at some length, the list including such names as those of the late A. L. Holley, the late Ashbel Welch, John B. Jervis, Coleman Sellers, and others, whose words are entitled to consideration, and whose advice may well be heeded by a student or a young engineer.

STATE RAILROAD COMMISSIONS AND HOW THEY MAY BE MADE EFFECTIVE. By Frederick C. Clark, Ph.D. The American Economic Association, Baltimore; price 75 cents.

This monograph is intended, as the author says, "to present a practical solution of some, at least, of the difficulties of the railroad problem, and to suggest a policy for the more efficient regulation and control of that most important of all our *quasi*-public industries."

The first part is devoted to a sketch of the growth and development of the State railroad commissions, and shows incidentally some of the difficulties involved in the present system, where one railroad may come under the jurisdiction of two or three different commissions with widely varying powers and differing policies. The second part is a discussion of the steps necessary to secure greater efficiency in the commission system.

Dr. Clark's suggestions for the improvement of the present system are the establishment of commissions in the States where none now exist, and the securing, as far as possible, of uniform laws to increase their efficiency. He also believes in co-operation between the State commissions and the Interstate Commerce Commission. He is a believer in the policy of submitting rates to regulation, and generally in increasing the authority of the commissions, especially in such matters as the inspection of roads and bridges, the investigation of accidents, and licensing the formation of new companies.

There are now in existence 34 State commissions, of which 17 have power to regulate rates, 13 have authority to supervise and advise only, and four are simply boards to assess railroad property for taxation. Eleven States and four Territories

have no commissions. The classification given above is a very general one, there being very considerable differences in the degree of authority given in each class.

While many, especially among railroad men, will differ with the opinions expressed in this book, all must admit that it is a useful one, and is of service in collecting and clearly stating the conditions of the question, and in showing the disadvantages of the present lack of anything approaching uniformity. The author is also clearly right in his appreciation of the importance attaching to the appointment of commissioners. The high standing and authority of the Massachusetts Commission has been much more due to the personal standing and force of its members than to the extent of its powers; for, under the law, it might have quickly become insignificant if made up of weak or inefficient men.

COSTA RICA. BULLETIN NO. 31 OF THE BUREAU OF THE AMERICAN REPUBLICS. Washington; issued by the Bureau.

This book of 150 pages is another of the excellent monographs issued by the Bureau of the American Republics, in pursuance of its design of collecting and putting in accessible shape information concerning the States of South and Central America. The present issue is in general form and design like those previously noticed; it contains a general account of the country; a historical sketch; much information about its soil, products, and people; a condensed account of the land laws; descriptions of the railroads and highways; full particulars of the postal arrangements, tariff laws, and similar matters; and lists of merchants, with some statistics as to imports and exports. It is a very convenient book for all who have business with Costa Rica or desire to extend their trade to that country.

The book is illustrated by a map and by a number of engravings from photographs of buildings, scenery, and points of interest.

ROAD CONSTRUCTION AND MAINTENANCE. *Prize Essays reprinted from the* Engineering Record, *selected by a Committee of Engineers.* Published by the *Engineering Record*, New York.

Some time ago the *Engineering Record* offered prizes for three essays on the construction and maintenance of highway roads. In response to this offer, a number of papers were sent in from which three were selected by a committee composed of three well-known engineers, Messrs. F. Collingwood, Edward P. North, and James Owen, who also pointed out five others as worthy of mention. The volume under consideration includes the three prize essays, with extracts from the others mentioned, with some brief comments and criticisms made by the committee.

There is just now a demand for literature on this subject, and the publication of these papers is timely. All of them contain some excellent suggestions, and, while naturally there are some things in each which are fairly subjects for criticism, they are on the whole worth a careful reading, and are an acceptable addition to the information which we already possess.

BRICK FOR STREET PAVEMENTS. *An Account of Tests made of Bricks and Paving Blocks, with a Brief Discussion of Street Pavements and the Method of Constructing them.* By M. D. Burke, C.E. Robert Clarke & Company, Cincinnati; price, $1.

A considerable part of this work was originally prepared as a report on the best material to be used in paving the streets of the village of Avondale, near Cincinnati. This required the testing of different kinds of material for paving, with results which are of general interest to all who are engaged in similar work. The tests included granite blocks, bricks, and paving blocks of various makes, and the results show that good brick will compare much more favorably with stone than is generally supposed.

Besides the account of the tests, there is a short discussion on street pavements in general and the materials best adapted for them, and of the best methods for building and maintaining municipal works generally, from the practical engineer's point of view. There is also some information as to the best methods of making, drying, and burning brick, and the best and most economical way of using them in paving.

The use of brick is far more economical than that of stone in many parts of the country, and the information given in this little volume is very acceptable.

TRANSACTIONS OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. VOLUME VIII., 1891. Published by the Institute, New York.

These *Transactions* make a volume of 634 pages, which contains many valuable papers read at the 12 meetings of the year, including the annual meeting, with the discussions upon them. The subjects chosen by the various writers are both theoretical and practical, and some of the late important applications of electricity are included.

While some of the papers are of much value, the discussions are perhaps the most interesting part. It often happens, indeed, in this as well as in other associations, that a paper is worth more for the discussion it calls out than in itself. The friction of argument will sometimes bring out facts and opinions which are not presented in the formal paper.

The volume is handsomely printed and bound, and its contents are a certificate of the activity and strength of the Institute.

RECORD OF SCIENTIFIC PROGRESS FOR THE YEAR 1891. By Robert Grimshaw, Ph.D. The Cassell Publishing Company, New York.

This "Record" is intended to set forth briefly the most important discoveries and improvements of the past year not only in all the branches of engineering, but in all the arts and sciences. It consists of a great number of brief notes classified under appropriate headings and covering a very wide range of subjects. The compiler has succeeded very well in condensing the information given into a very small space, and the amount of labor represented in the book is very considerable

Such a book as this defies criticism, for it is impossible for the critic to follow up all the different subjects, since no one man can possess the necessary knowledge. It has its uses as an index or directory to those who are in search of information on any special topic, and may also be of value to the general reader, who does not care to go too deeply into any one subject. Perhaps the best way to regard it is as a yearly supplement to an encyclopædia, helping to keep such a work up to date in these times of continual change.

The value of the book is considerably increased by the very full index which accompanies it.

THE IRON FOUNDER. *A Comprehensive Treatise on the Art of Molding.* By Simpson Bolland. John Wiley & Sons, New York; price, $2.50.

This book is in large part a record of practical experience in the foundry, which the author has decided to preserve and illustrate for the benefit of younger members of the trade. Some idea of the scope of the work will be given by the contents. Part I is a general introduction, describing the tools and appliances of a foundry, with some advice to those who are learning the business. Part II treats of Core Making; Part III, of Loam Molding; Part IV, of Dry-sand Molding; Part V,

of Green-sand Molding; while Part VI gives a variety of useful rules and tables.

The work should be a very useful one in its department. The descriptions are generally clear and plainly written, and are supplemented and completed by many illustrations. The rules given are generally plain, and are accompanied by the reasons for them, so that the reader is not obliged to take them simply on trust, but can study them out for himself.

More space in proportion, perhaps, is given to the difficult problems than to the more simple and ordinary work. This is very frequently the case, and is a very natural course, though perhaps not always the best. The young molder who reads this book, however, cannot fail to learn something; and the same remark will apply to his more experienced brother in the art.

NOTES AND EXAMPLES IN MECHANICS; WITH AN APPENDIX ON THE GRAPHICAL STATICS OF MECHANISM. By Professor Irving P. Church, Cornell University. John Wiley & Sons, New York; price, $2.

This book is intended as a companion to the author's "Mechanics of Engineering;" it contains notes and practical examples designed to illustrate more fully the application of fundamental principles. Among the subjects treated are Center of Gravity; Non-concurrent Forces in a Plane; Motion of a Material Point; Statics of Rigid Bodies; Moment of Inertia of Plane Figures; Dynamics of a Rigid Body; Mechanics of Materials and Graphical Statics The appendix contains a number of notes on the Graphical Statics of Mechanism, accompanied by examples.

In preparing this book, the author has had the advantage of continuous experience in the class-room, which is no inconsiderable one in showing the needs of students and the methods best suited for their instruction.

The appendix is based on the well-known work of Professor Herrman, with some improvements suggested by this experience with students. The book will be found a useful addition to the list of text-books on Mechanics.

CONTOUR MAP OF THE UNITED STATES. Compiled under the direction of Henry Gannett, Chief Topographer, by Harry King, Chief Draftsman, of the United States Geological Survey. Washington; issued by the Survey.

This admirably executed map has been compiled from the maps and charts of the Coast Survey, the Geological Survey, the Land Office, and the several State surveys which are available. It is on a scale of 1 : 2,500,000, or, approximately, 40 miles to an inch. The contour lines are drawn at elevations above sea level of 100 ft., 500 ft., 1,000 ft., 1,500 ft., 2,000 ft., and thence upward at each 1,000 ft. In compiling, wherever contour maps have been made from surveys, such maps have been generalized and reduced; elsewhere the contours have been based on heights measured by railroad and other surveys.

State and county lines, water-courses and railroads are shown on the map. It is arranged so that it can be used in sheets or mounted as a large wall map.

Accompanying it is a map of the United States on a single sheet on a scale one-third that of the larger map, or 1 : 7 500,000. This shows contours, and, in addition, State lines and water-courses.

The clearness and beauty of these maps make them a treat to a draftsman's eye.

BREADSTUFFS IN LATIN AMERICA. Issued by the Bureau of the American Republics, Washington.

This pamphlet, which is Bulletin No. 35 of the Bureau of the American Republics, is compiled from official returns, and shows the amount of the trade in breadstuffs between the United States on the one hand, and South America, Central America, and the West Indies on the other. It has also a variety of information as to tariffs, freight rates, and similar matters.

THE FIRST INTERNATIONAL RAILWAY AND THE COLONIZATION OF NEW ENGLAND: LIFE AND WRITINGS OF JOHN ALFRED POOR. Edited by Laura Elizabeth Poor. G. P. Putnam's Sons, New York; price, $3.

John Alfred Poor, who is called by his biographer a "hero of commerce," was for many years a prominent figure in Maine. A man of incessant activity, he worked for many years as an editor, a writer, and an advocate of projects for the development of his native State and its chief seaport. He was the first active advocate of the building of a railroad from Portland to Montreal, which was finally constructed as the eastern division of the Grand Trunk. When that was accomplished, he turned his attention to the European & North American Railroad, which he advocated "through good and evil report" until its success was assured, and he then turned his attention to the line to Rutland and Oswego, which was to draw to Portland the business of the lakes, and to make that city the leading port for Western trade. In this he failed, and the line was never built; but it was not for want of effort on his part.

With all his work as an editor and business man, he found time to write some historical papers requiring considerable research. These, with the more important of his other writings, are collected in this volume. His biographer has written a sympathetic rather than a critical life, and the whole is published in a handsome volume of 400 pages.

TRADE CATALOGUES.

Drawing Instruments, Protractors, Scales, etc. Illustrated and Descriptive Catalogue and Price List. Theodore Alteneder & Sons, 939-945 Ridge Avenue, Philadelphia.

This catalogue shows a great variety of drawing instruments and draftsmen's material, and its descriptive matter gives incidentally many useful hints. Prices are fully given, so that a draftsman can find not only just what he wants, but also just what it will cost him to get it. It is a very useful catalogue for reference and frequent consultation.

Sectional Catalogue Relating to Steam Hot Blast Apparatus for Heating and Ventilating Large Buildings. The Huyett & Smith Manufacturing Company, 1400 Russell Street, Detroit, Mich.

This catalogue gives a fully illustrated description of the Smith system of mechanical heating and ventilation, which has been introduced with much success in a number of shops, churches, schools, and other large buildings. As described, it seems a very simple and practical system, and it has been pretty fully tested by experience.

Injectors. The Rue Manufacturing Company, Philadelphia.

This is an illustrated catalogue of the different styles of injectors made by the Rue Manufacturing Company. Most of them are already well known and widely used but the catalogue will be of service both to those who already use them and may want to increase their number, and to those who need injectors and ought to consider those offered here.

Patent Improved Steam Hammers. David Bell, Buffalo, N. Y.

This catalogue illustrates the special type of steam hammer made by Mr. Bell, which includes a number of improvements

devised and introduced by him. The pamphlet is very neatly printed and illustrated.

Tight Valves at Last. Catalogue of the Roy Valve Company, New York. Illustrated.

Engineering Specialties for Steam, Water, Gas, Oil, and Chemicals. A. Aller, 109 Liberty Street, New York

Tobin Bronze: its Qualities and Uses. The Ansonia Brass & Copper Company, 19 Cliff Street, New York.

A Locomotive Coaling Station: Illustrated Description. The Link Belt Machinery Company, Chicago.

Sight-feed Lubricator for Locomotive Cylinders and Air Pumps: Illustrated Catalogue. The Michigan Lubricator Company. Detroit, Mich.

CURRENT READING.

THE May number of HARPER'S MAGAZINE completes the 84th volume of that periodical, which has now attained quite a venerable age. Years, however, seem only to increase its vigor. Among the papers in this number are one on the Dakotas, in the series on the Northwest; a continuation of the illustrated article on the Danube, and an important illustrated article on the German Army. The usual excellent variety of stories, sketches, and other lighter matter is also included in the number.

The May number of the OVERLAND MONTHLY contains some well-illustrated articles. One, by J. T. Goodman, treats of the rapidly growing Raisin Industry; another treats of the California Floral Society; a third, and very interesting one, treats of the Famous Street Characters of San Francisco, past and present. A historical paper on the date of the first discovery of Gold in California seeks to settle that disputed question by reference to the documents of the United States Mint.

In recent numbers of HARPER'S WEEKLY the illustrated descriptions of the Columbian Exposition buildings are continued. Among other articles there are illustrated papers on the new lands recently opened to settlement; on Improving Common Roads; on the New York Board of Trade and Transportation, and other interesting topics.

The latest issues of the NATIONAL GEOGRAPHIC MAGAZINE include President Gardiner G. Hubbard's annual address, on the Evolution of Commerce—a thoughtful and interesting paper; General A. W. Greely's report on the Geography of the Air; and the Mother Maps of the United States, by Mr. Henry Gannett, of the Coast Survey.

The usual variety of short and readable articles is found in GOLDTHWAITE'S GEOGRAPHICAL MAGAZINE for April, with two or three longer illustrated papers. Readers of almost every class will find something in this number to interest them.

A book on DYNAMOMETERS AND THE MEASUREMENT OF POWER, by Professor J. J. Flather, of Purdue University, is among the new works in preparation by John Wiley & Sons, New York.

The ECLECTIC MAGAZINE for April has an exceedingly good selection of articles from current English periodicals. The range of subjects is wide, and the papers are well chosen to show the general drift of English magazine writing at present. On this account only, without considering the value of the several articles, this magazine is well worth reading.

An Index to Volumes I to XL of the POPULAR SCIENCE MONTHLY is well advanced in preparation, and will be published in the course of the coming summer. The entire contents of the 40 volumes will be entered both by author and by subject in one alphabetical list, and the Index will have all the most approved features of the latest magazine indexes, besides some novel ones. The compiler is Mr. F. A. Fernald, of the editorial staff.

For April the editors of OUTING have presented a very attractive number, both in illustrations and reading matter. Almost every kind of sport finds its representative; there is some fiction also, and Lieutenant Bowen concludes his article on the Connecticut National Guard. This magazine has a field of its own, and fills it very acceptably.

Articles on Anthropological Work in Europe; on Cave Dwellings; on Folk-Lore, and on Herbert Spencer and the Synthetic Philosophy are included in the contents of the POPULAR SCIENCE MONTHLY for May, besides several others of minor importance.

The April number of MINERALS has articles on Our Tin Supply, on Feldspar, and several interesting shorter articles and notes.

The April number of GOOD ROADS continues Editor Potter's talk on Dirt Roads and Gravel Roads, with some more striking illustrations. Hon. John J. Ingalls writes on the Roads of the Western States; Hon. John W. Davis on those of Rhode Island; and Mr. Studebaker, of Indiana, discusses the question of who should build the country roads.

In the April number of the ENGINEERING MAGAZINE Mr. T. G. Gribble writes of the Lake Route from the West, and Professor Haupt discusses the question, Do Waterways Benefit Railways? Other articles are on Prospect Park, Brooklyn; the Pessimism of Modern Architecture; the New York Trade Schools; Municipal Government; Building a Railroad in the Southwest, and Making an Invention. Mr. Wisner renews his attack on the Engineer Corps, and submits an impracticable scheme for a Department of Engineering.

Among the subjects treated in CASSIER'S MAGAZINE for March are Ventilation of Engine and Boiler Rooms; Automatic Sprinklers; Steam Pumps for Fire Protection; the Alabama Iron Industry; the Production of Aluminum; Professional Certificates, and several other minor topics. The illustrations are generally good, giving the magazine an attractive appearance.

The Cleveland IRON TRADE REVIEW appears in a new dress, at the same time reducing its page to a more convenient size and adapting a neat cover. The REVIEW is an excellent paper, and its improved form indicates well-earned prosperity and a continued intention to improve.

The COMPASS for April continues the papers on Series of Numbers, and has short articles on the Slide Rule, the Transit and the Metric System.

In the second number of the JOURNAL OF THE UNITED STATES ARTILLERY there are articles on Sea Coast Guns and Steel Armor, by Lieutenant E. M. Weaver; Field Practice, by Lieutenant E. Russel, and the English Proving Ground, by B. C. Batcheller. There are also some translations and a number of short notes. The JOURNAL promises to be a valuable addition to professional literature.

A notable article in SCRIBNER'S MAGAZINE for May is on Rapid Transit in Cities, by Thomas Curtis Clarke, the well-known engineer; a special reference is made to the difficulties which Chicago will encounter in this respect next year. Professor N. S. Shaler begins a series of four articles on Sea and Land; Paul Lindau describes Unter den Linden in Berlin as one of the great streets of the world; Jacob A. Riis continues the series on the Poor in Great Cities, and in the Historic Moments series the receipt of the first Message by Telegraph is described by John W. Kirk, who was with Professor Morse at the time.

BOOKS RECEIVED.

Administration Report on the Railways in India: Part II. By Lieutenant-Colonel R. A. Sargeaunt, R.E., Officiating Director-General of Railways. Government Printing Office, Calcutta, India.

Magnetic Observations on the Shores of the Adriatic in the Years 1889 *and* 1890, *under Orders of the Marine Section of the Ministry of War of Austria-Hungary. By Captain Franz Laschober and Lieutenant Wilhelm Kesslitz.* Issued by the *Mittheilungen aus dem Gebiete des Seewesens*, Pola, Austria.

Ninth Annual Report of the Board of Railroad Commissioners, State of Kansas, for the Year ending December 1, 1891. *George T. Anthony, Albert R. Greene, W. M. Mitchell, Commissioners; Charles S. Elliott, Secretary.* State Printers, Topeka, Kans.

Reports from the Consuls of the United States to the Department of State: No. 137, *February*, 1892. Government Printing Office, Washington.

Master Car-Builders' Association Arbitration Cases Nos. 1 *to* 110; *December*, 1888, *to February*, 1892. Issued by the Association, Chicago.

Soft Steel in Bridges. By Frederick H. Lewis. Philadelphia. This is a reprint of a very interesting paper read by Mr. Lewis before the Engineers' Club of Philadelphia, accompanied by the discussion as reported for the Club.

Twenty-third Annual Report of the Board of Railroad Commissioners of Massachusetts: January, 1892. State Printers, Boston. This report has already been noticed from the advance sheets.

Annual Register of Purdue University, 1891–93. Lafayette, Ind.; issued by the University.

Quarterly Report of the Chief of the Bureau of Statistics, Treasury Department, Relative to the Imports, Exports, Immigration and Navigation of the United States for the Three Months ending September 30, 1892. *S. G. Brock, Chief of Bureau.* Government Printing Office, Washington.

Proceedings of the Engineers' Club of Philadelphia: Volume IX., No. 2. Issued by the Club, Philadelphia.

Census of Canada, 1891. *Bulletin No.* 5, *Manitoba, the Northwest, and British Columbia. Bulletin No.* 6, *Dwelling Houses. Bulletin No.* 7, *Livestock in the Northwestern Territories.* Department of Agriculture, Ottawa.

Suggestions of the Interstate Commerce Commission in Reply to Arguments on Senate Bill No. 892 *to Amend the Act to Regulate Commerce.* Government Printing Office, Washington.

Transactions of the American Institute of Electrical Engineers: Volume VIII, 1891. Published by the Institute, New York.

Catalogue of Lafayette College, 1891–92. Issued by the College, Easton, Pa.

1. *University Extension and its Leaders.* 2. *How to Begin University Extension.* 3. *Horatio Seymour on Higher Education.* Issued by the University Extension Department of the University of the State of New York, Albany.

A TEN-WHEEL PASSENGER ENGINE.

THE illustration given herewith is from a photograph of a ten-wheel passenger locomotive built by the Schenectady Locomotive Works for the Chicago, St. Paul, Minneapolis & Omaha Railroad, and intended to haul the heavy express trains on that road. The engine has no special features, but is an excellent example of the latest standard practice.

The boiler is of steel, and is of the wagon-top pattern, the barrel being 56 in. in diameter. The horizontal seams are quadruple-riveted with a welt-strip inside. The circumferential seams are double-riveted. The fire-box is of steel and is 90½ × 40¾ in. inside, the depth being 57½ in. at the front end and 54¼ in. at the back. The crown-sheet is stayed by crown-bars in the usual manner. The fuel is bituminous coal, and the grate of the rocking pattern. There are 240 tubes 2 in. in diameter and 12 ft. long. The heating surface is: Fire-box, 126.3 sq. ft.; tubes, 1,497.5 sq. ft.; total, 1,623.8 sq. ft. The grate surface is 25.5 sq. ft. The smoke-stack is 16 in. inside diameter, and the top is 15 ft. above the rail. The boiler is supplied by two Monitor injectors placed right and left. The usual working pressure of steam is 170 lbs.

The six driving-wheels are 64 in. in diameter. The driving-axle journals are 7½ × 8½ in. The truck is of the usual pattern, with 30-in. wheels, the truck-axle journals being 5 × 9 in. The driving-wheel base is 11 ft. 6 in.; the total wheel-base, 21 ft. 7 in. The tires of the forward driver are plain, so that the total rigid wheel-base is only 5 ft. 11 in.

The cylinders are 18 in. in diameter and 24-in. stroke. The piston packing is cast-iron rings, and the Jerome metallic packing is used for the piston-rod and valve-stem. The steam-ports are 16 × 1⅝ in. and the exhaust-ports 16 × 3 in. The valves are the Allen-Richardson balanced valve; they have ⅞ in. outside lap and $\frac{1}{32}$ inside lap. The greatest travel of the valve is 5½ in., and the lead in full stroke $\frac{1}{16}$ in. The exhaust nozzles are single, 4½, 4¾, and 5 in. in diameter.

The tender is carried on two four-wheel trucks of the Schenectady standard pattern, having channel iron bolsters, center-bearings front and back, with additional side-bearings on the back truck. The tender wheels are 33 in. in diameter, and the tender axle bearings 4½ × 8 in. The tender frame is of iron. The tank has a capacity of 3,300 gallons of water, and 5½ tons of coal are carried in the coal-box. The weight of the tender empty is 28,900 lbs.; loaded it is about 66,000 lbs.

The total length of the engine and tender is 54 ft. 5½ in. The total weight of the locomotive in working order is 116,000 lbs., of which 91,000 lbs. are carried on the driving-wheels.

SOME CURRENT NOTES.

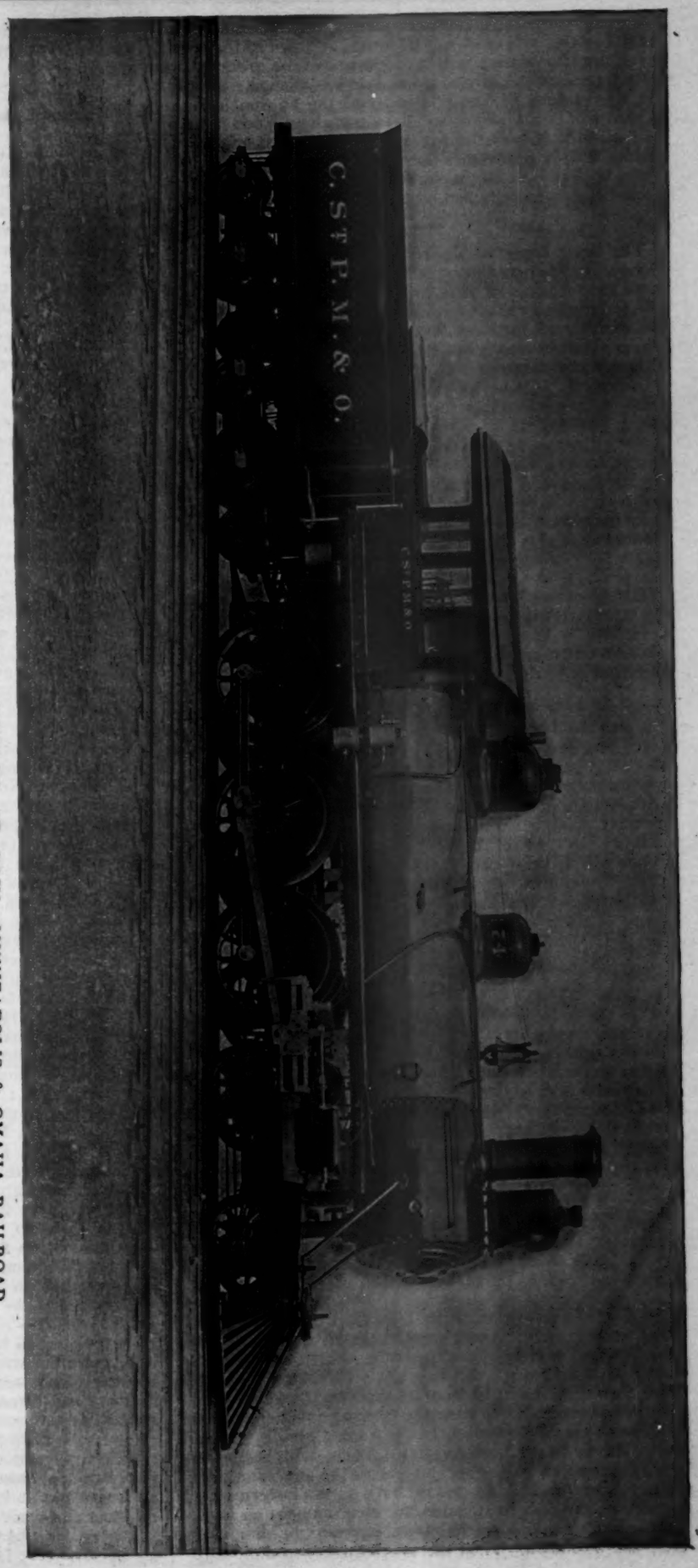
IT is now claimed that nickel-steel is especially well adapted for ship-building on account of its strength, which will permit the use of lighter plates. It is also said that when 3 to 5 per cent. of nickel is used the alloy will resist the corroding action of sea water, which is so injurious to ordinary steel plates.

THE Rapid Transit Commission, in Boston, has submitted an elaborate and carefully drawn report to the Legislature. It is comprehensive in its nature, and the Commission have taken into account not only the requirements of the city travel proper, but also the suburban business, and the much-discussed question of the rearrangement of the railroad stations. The plan presented by the Commission provides for the bringing together of all the lines entering Boston from the north and east, together with the Boston & Albany, in a large Union Station on Causeway Street, and an elevated connection between them and the station to be established for the southern lines. It also provides for an elevated line connecting the central part of the old city with the Charleston and Roxbury districts and with Cambridge. To secure these objects many changes will be necessary, not only in the construction of the elevated roads themselves, but in the widening of several of the streets and the opening of some new streets. The Commission has made its plan thus comprehensive in the hope of being able to provide for future as well as for the present requirements; it has entirely set aside all plans requiring underground construction, believing the elevated system to be much better. It is recommended that the Legislature establish a Commission to complete plans and carry them out as rapidly as possible.

CONSIDERABLE progress has been made toward establishing a railroad connection between Brazil and the River Plate. The Central Uruguay Railroad is now completed to the town of Rivera, on the Brazilian frontier, 352 miles from Montevideo. This town is only 120 miles from Bagé, the terminus of the Southern Brazilian Railroad, which extends to Rio Grande do Sul, about 170 miles, and it is not improbable that this gap will be filled before long.

AN interesting structure is shortly to be built over the Neva, in St. Petersburg. It will connect the open space known as Mars Square with the Petropavlovsk Citadel, in which is the church containing the graves of the imperial family, and will complete communication between this citadel and the famous Winter Palace. At present, and for many years past, a pontoon bridge has been used, known as the Trinity Bridge; and this is, of course, liable to obstruction in autumn and in spring when the ice is going out of the river. The matter is in charge of a committee appointed by the St. Petersburg City Council. A new floating bridge is to be built on this site, and the new structure will be on the site of the old pontoon bridge. The preliminary surveys and design are being prepared; the opening is to be 250 sagenes, or about 1,750 ft., but it is not yet decided whether this opening shall be divided into three or five spans. The structure will be so planned as not to obstruct in any way the fine view of the banks and of the other bridges over the Neva.

PLANS have been prepared for one of the great bridges which it is proposed to build across the East River at New York. This one is a cantilever bridge, which the Long Island Railroad wants to build just below the south end of Blackwell's Island, and it is intended to be entirely a railroad bridge. The plans provide for a cantilever 3,540 ft. long; in all there will be three spans over the river—one 1,000 ft. long over the west channel, one 690 ft. over the reef south of Blackwell's Island, and one 1,100 ft. long over the west channel. The piers will be placed at the water edge on either shore, and on the reef, offering no obstruction to navigation. The bridge is to have a clear height of 135 ft. above high water. At the New York end it is proposed to extend it by an elevated structure to a point somewhere near Thirty-eighth Street and Fourth



TEN-WHEEL PASSENGER LOCOMOTIVE, CHICAGO, ST. PAUL, MINNEAPOLIS & OMAHA RAILROAD.

BUILT BY THE SCHENECTADY LOCOMOTIVE WORKS, SCHENECTADY, N. Y.

Avenue, where the passenger station will be built. The tracks on this side will not be brought down to the street level, but the station will be high above the ground, and passengers will be carried up and down in large elevators. On the eastern or Long Island end the approach to the bridge will be an iron or steel viaduct about 9,000 ft. long, and will descend to the present level of the Long Island tracks with a grade of 1 per cent. It is stated the Company is ready to begin work as soon as the necessary authority can be obtained.

THE April report of pig iron production, as given by the *American Manufacturer*, shows that on April 1 there were 280 furnaces in blast, with a total weekly capacity of 188,109 tons—a reduction from March 1 of 10 per cent. in the number of furnaces, and of 3 per cent. in capacity. The reduction was greatest in the anthracite furnaces, although the charcoal and bituminous furnaces also show a falling off. It is not unlikely that the reduction will continue for some time, as the unsold stocks of pig iron are large, and makers do not want to increase them.

Notwithstanding the reduction noted, the manufacture of iron is very much more active than last year. Comparing the statement above with that for April 1, 1891, there is shown an increase of 49, or 21 per cent, in the number of furnaces in blast, and of 74,793 tons, or 66 per cent. in their total weekly capacity.

THE German Canal unions have decided to take part in the International Congress of Inland Navigation, which is to be held in Paris in July next. Much interest is felt in inland navigation in Germany at present, and the representation at Paris will probably be large.

A NEW bridge, which is to be built over the Raritan River and the Delaware & Raritan Canal at New Brunswick, N. J., presents some points of interest. The section over the canal consists of a plate girder span of 62 ft. and a draw-span of 130 ft.; but the river span is to be of masonry, having seven arches, each of 75 ft. span. The masonry will be of brick faced with granite, and the arches will have a rise of 15 ft. only, or one-fifth of the span. The contract for this bridge has been let to Dean & Westbrook, of New York.

COLUMBIAN EXPOSITION NOTES.

IT is stated that Major Meigs, the Engineer in charge of river improvements at Keokuk, Ia., is preparing for exhibition working models of the Government dry docks and engine house, the various boats used in making river improvements and sections of dams, showing the manner of their construction. It is announced that in the Government exhibit will appear a photographic panorama of the Mississippi River from St. Paul to the mouth of the Illinois.

THE Canadian Pacific Railroad Exhibit will include a complete passenger train, and models of its Pacific steamers.

IN the marine section of the Department of Transportation, arrangements have been made to exhibit, among other things, models of the rig of the old frigate *Constitution*; of the *Victory*, the flagship of Nelson; a caravel from Spain, the exact copy of the *Santa Maria*, in which Columbus made his first voyage; canoes of the native traders of the West Indies, hewn from a single tree and propelled by twenty-five paddles. There will be models of such modern racing schooners as the *America*, *Mayflower*, *Puritan* and *Volunteer*. All sorts of stern-wheel passenger and freight steamers for river navigation, steel-screw ferry-boats, electric pinnaces, naphtha launches, etc., will be shown. Then there will appear in their natural order ketches and brigantines, sloops and barks of the Atlantic coast in 1714, rafts, arks, barges, keel-boats and other craft.

SOME BALTIMORE & OHIO HISTORY.

THE table given herewith is a reproduction of a printed sheet of locomotive returns issued by the Baltimore & Ohio Company in 1850—over forty years ago—and the list of engines contained in it is a very interesting one. At that time the road was in operation from Baltimore to Cumberland, 178 miles, and it was nearly completed to Piedmont, 28 miles further. It was not opened to the Ohio River until three years later, in 1853. On this 178 miles, it will be seen that 64 engines were in use, and that they made a total mileage, including the Washington Branch, of 1,215,715 miles, or an average of 18,996 miles each. Some of them show an excellent record for that day, although the mileage is hardly up to the present standard; the greater distance run during the year having been 38,943 miles, which was made in passenger service by the engine *Delaware*, a comparatively new engine. The *Minerva*, an Eastwick & Harrison engine, came next to this with 36,750 miles. The greatest mileage shown by a freight engine was 27,120 miles, which was made by the *Atlas*, also an Eastwick & Harrison engine, which had then been on the road for 11 years, having been built in 1859.

It may be interesting to note that the first four engines on this return—Nos. 1, 2, 3 and 4, which were built by Phineas Davis, at York, Pa., in 1834 and 1835—are still in service at the Mt. Clare shops in Baltimore. These are of the class known as the grasshopper, having an upright boiler and upright cylinders, the motion being transmitted from the driving-wheels through a walking beam. Many of our readers have probably seen one of these engines or an engraving of it. The growth of the road is shown by the fact that for the year ending September 30, 1892, there were 611 engines in service on the Company's lines, and their total mileage for the year was 22,106,204 miles.

The engine No. 1 shown in the list was not the first engine built for the road. The first engine built for regular service—after the trial of Peter Cooper's little experimental machine—was the *York*, which was built by Phineas Davis, and was of the grasshopper pattern. It was shortly followed by two others, which did all the work on the road to July, 1834, when four more were purchased, including the *Arabian*, which is No. 1 on the performance sheet given. The others followed in numerical order.

In this connection it may be of interest to repeat some of the historical facts in relation to the building of the Baltimore & Ohio which have been published before, but may be convenient for reference. The road was opened first for traffic by horse power to Ellicott's Mills, 14 miles from the starting-point in Baltimore, May 24, 1830. It reached Frederick, 61 miles, December 1, 1831; Point of Rocks, 69 miles, April 1, 1832; Harper's Ferry, 81 miles, December 1, 1834; Hancock, 123 miles, June 1, 1842; Cumberland, 178 miles, November 5, 1842; Piedmont, 206 miles, July 21, 1851; Fairmont, 302 miles, January 22, 1852; Wheeling, 379 miles, June 1, 1853.

The Washington Branch was completed to Bladensburg, 32 miles from Baltimore and 24 from the Relay House, July 20, 1834, and to Washington, 40 miles, a month later, on August 25, 1834.

It must be remembered that the Baltimore & Ohio was the most difficult piece of railroad work which had yet been undertaken at the time of its construction. Its location involved the use of grades which many engineers at that time believed to be impracticable, while some of the tunnels and other works on the section crossing the Alleghanies were on a scale exceeding anything yet undertaken. It is not to be wondered at that its progress was comparatively slow.

The Baltimore & Ohio also claims the honor of being the first railroad company incorporated in America, having been organized April 24, 1827, with Philip E. Thomas as President and George Brown as Treasurer. Actual construction work was begun July 4, 1828.

The charter, as presented to the Legislature, was drawn up by Mr. J. V. L. McMahon, and a characteristic anec-

Table G.

Statement of the Number of LOCOMOTIVES on the MAIN STEM and WASHINGTON BRANCH, owned by the Baltimore & Ohio Railroad Company, and exhibiting approximately the Nett Cost of Expenses for Repairs, &c. of the same, for the year ending 30th September, 1850.

MAIN STEM.

Nos. of Engines.	NAMES OF ENGINES.	BUILDER'S NAME	When placed on the Road.	CLASS.	Miles run with Passengers.	Miles run with Tonnage.	Total Number Miles run.	Cost of Repairs of each Engine.	Amount of cost of rebuilding carriages included in repairs.	Average cost of each Engine per mile run.	REMARKS
33	Hercules	Ross Winans	October 1844	1	.....	13,542	13,542	$ 910.77	.....	6.72	
34	Gladiator	" "	November, 1844	1	.....	16,015	16,015	1,736.75	.....	10.84	
35	Buffalo	" "	November, 1844	1	.....	15,622	15,622	1,729.76	420.00	11.07	
36	Baltimore	" "	December, 1844	1	.....	16,008	16,008	1,936.01	.....	12.09	
37	Cumberland	" "	July, 1845	1	.....	16,737	16,737	1,171.24	.....	6.99	
38	Elephant	" "	July, 1845	1	.....	18,573	18,573	1,379.20	275.00	7.42	1st Class—averaged per Mile run 7.04
40	Opequan	" "	July, 1846	1	.....	19,412	19,412	1,262.81	.....	6.50	2d " " " " 5.34
41	Elk	" "	August, 1846	1	.....	17,180	17,180	1,563.36	.....	9.09	3d " " " " 4.66
42	Catoctin	" "	October, 1846	1	.....	15,886	15,886	1,564.06	.....	9.91	4th " " " " 3.79
43	Youghiogheny	" "	November, 1846	1	.....	23,114	23,114	1,463.77	.....	6.34	
45	Tuscarora	" "	December, 1846	1	.....	17,101	17,101	1,389.85	.....	8.12	
46	Allegany	" "	December, 1846	1	.....	11,811	11,811	919.48	.....	7.78	
49	Mount Clare	Balto & Ohio R R Co	May, 1847	1	.....	9,187	9,187	763.62	.....	8.31	
54	Hero	" " "	May, 1848	1	.....	25,072	25,072	496.89	.....	1.98	
55	Camel	Ross Winans	June, 1848	1	.....	12,621	12,621	1,920.95	704.00	15.20*	
56	Saturn	New Castle Manufact'g Co	June, 1848	1	.....	18,672	18,672	1,055.26	.....	5.63	
57	Memnon	" "	July, 1848	1	.....	25,008	25,008	615.86	.....	2.46	
58	Hector	M. W. Baldwin	October, 1848	1	.....	17,987	17,987	1,652.72	.....	9.18	
59	Iris	Ross Winans	December, 1848	1	.....	20,951	20,951	1,570.13	.....	7.49	
60	Cossack	M. W. Baldwin	December, 1848	1	.....	13,484	13,484	1,436.09	.....	10.65	
61	Mars	Ross Winans	December, 1848	1	.....	18,464	18,464	1,486 34	.....	8.05	
62	Tartar	M. W. Baldwin	January, 1849	1	.....	10,176	10,176	1,122.03	.....	11.03	
63	Giant	Balto. & Ohio R. R. Co	May, 1849	1	.....	24,172	24,172	265.09	.....	1.09	
64	Lion	" " "	March, 1850	1	.....	12,783	12,783	137.39	.....	1.07	
26	Vulcan	Eastwick & Harrison	July, 1840	2	.....	23,188	23,188	543.42	.....	2.34	
44	Baldwin	M W Baldwin	November, 1846	2	.....	15,299	15,299	2,129.99	830.00	13.90	
50	Wisconisco	" "	December, 1847	2	.....	22,046	22,046	1,279.24	.....	5.80	
51	Dragon	" "	January, 1848	2	.....	19,549	19,549	744.23	.....	3.71	
53	Unicorn	" "	February, 1848	2	.....	21,549	21,549	717.77	.....	3.33	
16	Philip E Thomas	William Norris	June, 1838	3	.....	24,357	24,357	269.45	.....	1.10	
17	Mazeppa	Gillingham & Winans	October, 1838	3	.....	13,485	13,485	1,067.90	.....	7.91	
23	Atlas	Eastwick & Harrison	September, 1839	3	.....	27,120	27,120	1,385.88	300.00	4.74	
25	Vesta	William Norris	November, 1839	3	.....	16,904	16,904	596.20	.....	4.13	
27	Jupiter	Eastwick & Harrison	February, 1840	3	.....	22,202	22,202	1,118.24	.....	5.03	
29	Mercury	" "	July, 1842	3	28,789	.....	28,789	2,763.93	1,520.00	9.60	
30	Minerva	" "	February, 1842	3	36,750	.....	36,750	992.09	.....	2.70	
31	Stag	William Norris	May, 1843	3	3,048	19,830	22,878	1,362.34	.....	5 95	
32	Atlanta	Ross Winans	October, 1843	3	.....	25,219	25,219	1,064.56	.....	4.22	
39	Reindeer	" "	December, 1845	3	3,410	19,875	23,285	1,146.34	.....	4.92	
48	Delaware	New Castle Manufact'g Co	January, 1847	3	38,943	.....	38,943	1,201.13	.....	3.08	
52	Juno	Ross Winans	January, 1848	3	4,938	22,971	27,909	719.82	.....	2.56	
1	Arabian	Phineas Davis	July, 1834	4	.....	19,030	19,030	762 31	.....	4.00	
2	George Washington	" "	October, 1834	4	.....	12,628	12,628	585.33	.....	4.63	
3	Thomas Jefferson	" "	June, 1835	4	1,056	14,627	15,683	566.19	.....	3.61	
4	James Madison	" "	June, 1835	4	.....	25,375	25,375	462.42	.....	1.82	
5	James Monroe	" "	June, 1835	4	.....	10,993	10,993	635.09	.....	5.77	
6	John Q. Adams	" "	July, 1835	4	.....	5,259	5,259	625.99	.....	1.19	
7	Andrew Jackson	" "	February, 1836	4	.....	20,511	20,511	469.43	.....	2.28	
8	John Hancock	Gillingham & Winans	April, 1836	4	.....	13,345	13,345	398.26	.....	2.98	
9	Phineas Davis	" "	August, 1836	4	.....	6,303	6,303	309.67	.....	4.91	
10	George Clinton	" "	August, 1836	4	.....	14,892	14,892	655.02	.....	4.39	
11	Martin Van Buren	" "	November, 1836	4	.....	25,217	25,217	621.35	.....	2.46	
12	Benjamin Franklin	" "	April, 1837	4	.....	18,623	18,623	443.22	.....	2.37	
14	William Patterson	" "	June, 1837	4	.....	22,705	22,705	855.36	.....	3.76	
19	William Cook	William Norris	December, 1838	4	22,576	.....	22,576	298.65	.....	1.32	
20	Patapsco	" "	July, 1839	4	6,946	4,152	11,098	512.36	.....	4.61	
21	Monocacy	" "	July, 1839	4	.....	12,683	12,683	613.02	.....	4.85	
22	Potomac	" "	August, 1839	4	3,700	13,105	16,805	1,011.91	.....	6.02	
24	Pegasus	" "	November, 1839	4	16,580	.....	16,580	1,212.32	570.00	7.31	
	59 Engines M. S.				166,736	942,620	1,109,356	$59,598 96	$4,619.00		

WASHINGTON BRANCH.

15	Isaac McKim	Gillingham & Winans	May, 1838	3	.....	21,702	21,702	834.19	.....	3.84	
28	Arrow	New Castle Manufact'g Co.	February, 1840	3	15,945	.....	15,945	2,081.62	1,067.44	13.05*	
47	New Castle	" " "	December, 1846	3	27,693	.....	27,693	1,460.73	375.00	5.24	
13	La Fayette	William Norris	April, 1837	4	24,630	.....	24,630	506 81	.....	2.05	
18	Jos. W. Patterson	" "	October, 1838	4	.....	16,389	16,389	452.97	.....	2.76	
	5 Engines W. B.				68,368	38,091	106,359	$5,336.32	$1,442.44		
	59 " M. S.										
	64 Total.										

*The repairs of the Engine "Arrow" were extraordinary, including a new furnace, enlargement, and a new crank shaft, new truck frame, &c.

A like remark is due to the Engine "Camel."

dote has been preserved in relation to it. After Mr. McMahon had prepared the document, it was read by him to the committee for their adoption. During the reading, as provision after provision was gone over, and the varied and comprehensive powers which the distinguished author had embraced in it were one by one unfolded, the venerable Robert Oliver (one of the first Board of Directors) arose, and in his peculiarly blunt and off-hand manner exclaimed, "Stop, man; you are asking for more than the Lord's Prayer!" Mr. McMahon smilingly replied "that it was all necessary; and the more they asked for the more they would get." Mr. Oliver then rejoined, "Right, man; go on."

This oldest of the trunk lines will, it is understood, have a very interesting historical exhibit at Chicago next year.

It will be of interest to recapitulate here the circumstances attending the building of the first locomotive regularly used on the road. On January 4, 1831, the Baltimore & Ohio Railroad Company issued an advertisement to the inventive genius and mechanical skill of the country, offering most liberal inducements for the production of locomotive steam engines. This being the first proposal

ever issued in the United States for locomotives, will be read with general interest. It was as follows :

OFFICE OF THE BALTIMORE & OHIO RAILROAD COMPANY.
4th January, 1831.

The Baltimore & Ohio Railroad Company being desirous of obtaining a supply of Locomotive Engines of American manufacture, adapted to their road, the President and Directors hereby give public notice, that they will pay the sum of Four Thousand Dollars for the most approved Engine which shall be delivered for trial upon the road on or before the 1st of June, 1831, and that they will also pay Three Thousand Five Hundred Dollars for the Engine which shall be adjudged the next best and be delivered as aforesaid, subject to the following conditions, to wit :

(1) The Engine must burn coke or coal, and must consume its own smoke.

(2) The engine, when in operation, must not exceed three and one-half tons weight, and must, on a level road, be capable of drawing day by day, fifteen tons, inclusive of the weight of the wagons, fifteen miles per hour. The Company to furnish wagons of Winans construction, the friction of which will not exceed five pounds to the ton.

(3) In deciding on the relative advantages of the several engines, the Company will take into consideration their respective weights, power and durability, and, all other things being equal, will adjudge a preference to the engine weighing the least.

(4) The flanges are to run on the inside of the rails. The form of the cone and flanges, and tread of the wheels must be such as are now in use on the road. If the working parts are so connected as to work with the adhesion of all the four wheels, then all the wheels shall be of equal diameter, not to exceed three feet, but if the connection be such as to work with the adhesion of two wheels only, then those two wheels may have a diameter not exceeding four feet, and the other two wheels shall be two and a half feet in diameter, and shall work with Winans' friction wheels, which last will be furnished upon application to the Company. The flanges to be four feet seven and a half inches apart from outside to outside. The wheels to be coupled four feet from center to center in order to suit curves of short radius.

(5) The pressure of the steam not to exceed one hundred pounds to the square inch, and as a less pressure will be preferred, the Company in deciding on the advantages of the several engines will take into consideration their relative degrees of pressure. The Company will be at liberty to put the boiler, fire tube, cylinder, etc., to the tests of a pressure of water not exceeding three times the pressure of the steam intended to be worked, without being answerable for any damage the machine may receive in consequence of such tests.

(6) There must be two safety valves, one of which must be completely out of reach or control of the engineman, and neither of which must be fastened down while the engine is working.

(7) The engine and boiler must be supported on springs and rest on four wheels, and the height from the ground to the top of the chimney must not exceed twelve feet.

(8) There must be a mercurial gauge affixed to the machine with an index rod, showing the steam pressure above fifty pounds per square inch, and constructed to blow out at one hundred and twenty pounds.

(9) The engines which may appear to offer the greatest advantages will be subjected to the performance of thirty days' regular work on the road ; at the end of which time, if they have proved durable, and continue to be capable of performing agreeably to their first exhibition, as aforesaid, they will be received and paid for as here stipulated.

P. E. THOMAS,
President.

N. B.—The Railroad Company will provide and will furnish a tender and supply of water and fuel for trial. Persons desirous of examining the road or of obtaining more minute information, are invited to address themselves to the President of the Company. The least radius of curvature of the road is 400 feet. Competitors who arrive with their engines before the first of June, will be allowed to make experiments on the road previous to that day.

The editors of the *National Gazette*, Philadelphia ; *Commercial Advertiser*, New York ; and Pittsburgh *Statesman*, will copy the above once a week for four weeks and forward their bills to the B. & O. R. R. Co.

During the summer of 1831, in pursuance of this call upon American genius, made by the directors, three locomotive steam engines were placed upon the railroad, only one of which, however, was made to answer any good purpose.

This engine, called the *York*, was built at York, Pa., by Phineas Davis (or rather Davis & Gartner), and after undergoing certain modifications, was found capable of conveying 15 tons at 15 miles per hour, on a level portion of the road. It was employed on that portion of the road between Baltimore and Ellicott's Mills, and generally performed the trip to the Mills in one hour, with four cars—being a gross weight of about 14 tons. This engine was mounted on wheels like those of the common cars, of 30 in. in diameter, and the velocity was obtained by means of gearing with a spur-wheel and pinion on one of the axles of the road wheels. The curvatures were all traveled with great facility by this engine, its greatest velocity for a short time on straight parts of the road having been at the rate of 30 miles per hour, while it frequently attained that of 20 miles, and often traveled in curvatures of 400 ft. radius at the rate of 15 miles per hour. The fuel used in it was anthracite coal, which answered the purpose well ; but the engine weighing but 3½ tons was found too light for advantageous use on ascending grades. This engine was of the "grasshopper" type, referred to above, and has been heretofore illustrated.

The performance of this engine fully confirmed the belief of the Board and its Engineer corps, that locomotive engines might be successfully used on a railroad having curves of 400 ft. radius, and from that time forward every encouragement was given by the Company to the inventive genius of the country, to improve on the partially successful experimental engine that had been produced by Mr. Davis.

On April 1, 1832, the first train of cars bearing produce which had descended the Potomac to the Point of Rocks, arrived in Baltimore ; the trade from that point continued from that time to increase rapidly, and warehouses, dwellings, and public houses were erected there, and quite a town soon formed. The travel and trade to Frederick, and the increasing business of that portion of the Main Stem between the Monocacy and the Point of Rocks were soon found to constitute no unimportant item in the general receipts of the Company.

CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.

CHEMISTRY APPLIED TO RAILROADS.
XXVII.—SAMPLING; AND THE ENFORCEMENT OF SPECIFICATIONS.

BY C. B. DUDLEY, CHEMIST, AND F. N. PEASE, ASSISTANT CHEMIST, OF THE PENNSYLVANIA RAILROAD.

(Copyright, 1889, by C. B. Dudley and F. N. Pease.)

(*Continued from page* 163.)

IN this article we propose to give the method of obtaining the samples from the shipments, and the routine that is followed from the time the specifications are completed up to the paying of the bill for the materials, together with the method of procedure in case of the acceptance or rejection of shipments.

* These articles contain information which cannot be found elsewhere. No. I, in the JOURNAL for December, 1889, is on the Work of the Chemist on a Railroad; No. II, in the January, 1890, number, is on Tallow, describing its impurities and adulterations, and their injurious effects on the machinery to which it is applied; No. III, in the February number, and No. IV, in the March number, are on Lard Oil ; No. V, in the April number, and No. VI, in the May number, on Petroleum Products ; No. VII, in the June number, on Lubricants and Burning Oils ; No. VIII, in the July number, on the Method of Purchasing Oils ; No. IX, also in the July number, on Hot Box and Lubricating Greases ; No. X, in the August number, on Battery Materials ; No. XI, in the September number, on Paints ; No. XII, in the October number, on the Working Qualities of Paint ; No. XIII, in the December, 1890, number, on the Drying of Paint ; No. XIV, in the February number, on the Covering Power of Pigments ; No. XV, in the April number, on How to Design a Paint ; No. XVI, in the May number, on Paint Specifications ; No. XVII, in the June number, on the same subject, and No. XVIII, also in June, on the Livering of Paint ; No. XIX, in the July and August numbers, on How to Design a Paint ; No. XX, in the September number, on Disinfectants ; No. XXI, in the October number, on Mineral Wool, and No. XXII, in the same number, on Wood Preservative ; No. XXIII, in the November and December numbers, on Soap ; No. XXIV, in the January, 1892, number, on Steel for Springs ; No. XXV, in the February number, on Bearing Metals ; No. XXVI., in the April number, on How to Make Specifications.

Let us suppose that the specifications for any material have been prepared which the railroad company desires to use. These specifications are put in print, and quite a stock is prepared. The Purchasing Agents are furnished with a quantity of these specifications, which they send out to the parties who furnish the material, with a note to the effect that on all orders placed with them hereafter materials must be furnished which will conform to these specifications. It will thus be seen that in reality the specifications are a part of the contract as previously stated, and are regarded as binding not only on the manufacturer furnishing the material, but also on the party who buys it.

In the regular routine requisitions for materials come to the Purchasing Agent, and he sends orders to whoever he may decide for any of the materials for which specifications have been prepared. The materials are then delivered by the manufacturers to the nearest station, and in due course of time are transferred to the shop specified on the order.

As soon as the material arrives at the shop, a representative of the Company takes a sample. It will have been observed that in some cases where it seemed necessary to do so, the method of taking the sample has been described in the specifications. In some cases the method of taking the sample is so simple that no special description is necessary. Several points, however, in regard to taking sample are insisted upon absolutely.

First, the sample must always be taken by a repesentative of the Company, and in no case by the manufacturer or any of his representatives.

Second, in the cases of a large number of materials, the shipment is received at the place for which it is designed before the sample is taken. In other cases, however, such as spiral springs, phosphor-bronze, etc., the material may be sampled by the Company's representative at the works before shipment takes place, but in this case the shipment must take place before the Company's representative leaves the works.

Third, in no case shall an average sample be taken, and in most cases only a single sample shall represent the shipment. In some cases, as in the case of phosphor-bronze or mineral wool, two or three samples from different portions of the shipment are taken to represent that shipment.

The following instructions have been issued for the use of the men who do the sampling. The circular applies to both the chemical and physical testing departments, and only that part applying to the chemical testing department is given.

PENNSYLVANIA RAILROAD COMPANY.

PENNSYLVANIA RAILROAD DIVISION.

Motive Power Department.

Circular No. 1.

Instructions for Ordering, Inspecting, and Sampling Materials.

I. Hereafter all requisitions for any of the materials mentioned below must specify the same "As per P. R. R. Co. Specifications." As new specifications are prepared from time to time, instructions in regard to the inspection and sampling of the materials specified will be issued and must be carefully observed.

II. When material has been received, it must be carefully inspected and compared with the bill. If any discrepancies are found, a statement of same, together with the bill, not signed, must be sent at once to the Superintendent of Motive Power for adjustment.

III. The instructions given below must be rigidly observed, and in no case must any portion of a shipment be used until report of test, announcing materials ready for use, has been received, except by special permission from the Superintendent of Motive Power. The report of test must always be attached to bill when this is signed.

IV. The above instructions do not apply to materials received by one shop from another, but only to those received from manufacturers or dealers.

V. The inspection and testing of materials will be done in part by or under the supervision of the party to whom the materials are consigned, and in part by or under the supervision of the Chemist and the Mechanical Engineer, at Altoona.

VI. The following materials must be inspected and sampled, as is described under each heading. The samples must be sent by passenger train to Pennsylvania Railroad Company, care of Charles B. Dudley, Chemist, Altoona, using for this purpose the "sample for test" tags, and filling in the blank spaces as far as possible.

OILS AND TALLOW.

From every shipment of a car load or less of extra lard oil, extra No. 1 lard oil, tallow oil, neatsfoot oil, 150° fire-test burning oil, 300° fire-test burning oil, paraffine oil, well oil, 500° fire-test oil, and of tallow, one sample must be sent, which may be taken from any barrel at random. In sending the sample, it is recommended to use the can and box approved by the General Superintendent of Motive Power, March 7, 1884. These boxes and cans will be returned, for continuous use, to the shops from which they are sent. If in any shipment of a certain kind of oil, any of the barrels are found filled with another kind of oil, or oil of same kind but inferior grade, such barrels must not be used; also, every barrel in each shipment of 150° and 300° fire-test oils must be examined as soon as received, rolling the barrels about before examination. All barrels which are found to contain cloudy oil or oil of inferior color must be set aside. In both these cases samples of either the inferior, the wrong kind, or the cloudy oil must be sent, as above directed, for decision as to what shall be done with it, and a letter written to the Superintendent of Motive Power in regard to the matter.

ZINC.

From every shipment a sample of about half a pound, broken off from any plate or rod at random, must be sent as above directed.

SULPHATE OF COPPER.

From every shipment a sample of about half a pound, taken from any barrel at random, must be sent as above directed. The shipment must also be carefully inspected by a competent person to see that it will all go through a sieve $1\frac{1}{2}$ in. mesh and contain nothing that will go through a sieve of $\frac{3}{16}$ in. mesh. It may be necessary to empty one or more barrels for this purpose. Should the shipment be found not to fill these requirements it must be returned to the shippers.

SAL AMMONIAC.

From every shipment a sample of about half a pound, taken at random, must be sent as above directed.

COMMON SOAP.

Common soap will be bought by weight, and requisitions must be made accordingly. The bars usually weigh 1 lb. From every shipment one bar, taken at random, must be sent as above directed. The tag must state the number of bars in the shipment.

TOILET SOAP.

Toilet soap will be bought by weight, and requisitions must be made accordingly. Cakes of toilet soap usually weigh one quar er of a pound. From every shipment one cake, taken at random, must be sent as above directed. The tag must state the number of cakes in the shipment.

CABIN CAR COLOR.

This material will always be bought dry, and requisitions must be made accordingly. From every shipment a sample of about one quarter of a pound, taken at random from any package, must be sent as above directed.

DISINFECTANT.

This material is made by the laboratory at Altoona, and is furnished either in barrels or in boxes containing two dozen 8-ounce bottles. It is obtained by requisition on Altoona shops, and is ready for use when received.

CAUSTIC SODA.

If this material is received in $\frac{1}{4}$ lb. or 1 lb. boxes, one box taken at random from every shipment must be sent as above directed, and the tag must state the number of boxes in the shipment. If the material is received in barrels or drums, a sample of about half a pound must be sent in a closed tin box as above directed. The gross weight of the shipment must also be verified, and the tag must state the net weight of the shipment.

FREIGHT CAR COLOR.

From every shipment a sample of about a pound must be sent as above directed. Use can and box, same as with oil samples, except that can should have screw top not less than 1¼ in. diameter and can should not be filled more than half full.

MINERAL WOOL.

From every shipment three samples of about half a pound each must be sent as above directed. Each sample must be from a different bag, and must not be compressed during taking or shipment of sample.

PHOSPHOR-BRONZE.

Phosphor-bronze is purchased in lots of 20,000 lbs., or some whole multiple of this number. Requisitions must be made out accordingly. This material is inspected and weighed at point of shipment, and is ready for use when received with report of Inspector and Chemist.

LOCOMOTIVE SPRING STEEL.

From every shipment a sample about three (3) in. long cut off from any bar must be sent as above directed. The sample for test tag must give the size of the bar, as well as the amount in the shipment. If more than one size bar is received in one shipment, a sample of each size must be sent, with a separate tag for each sample.

HELICAL SPRINGS.

These articles are sampled by the Inspector at the works, who at the same time makes the physical test. The shipments are ready for use when received with the reports of the Inspector and Chemist.

DETERGENT.

The shipment must be weighed when received, and a sample of the dry material sent in a box.

WOOD PRESERVATIVE.

From every shipment a sample of about a pint must be sent as above directed. Use the same kind of can and box as with oil samples.

TUSCAN RED.

From every shipment a sample of about a pound must be sent as above directed. Use can and box same as with oil samples, except that can should have screw top not less than 1¼ in. diameter, and can should not be filled more than half full.

Approved.

THEODORE N. ELY,
General Superintendent Motive Power.

Office of General Superintendent Motive Power, Altoona, Pa., June 1, 1887.

The transfer of the sample from the shop or point at which it is taken to the laboratory is done by passenger train. In the case of liquids, a tin can holding about a pint, with a screw top, such as can readily be obtained in the market, is used. These cans are marked with paint on the outside with the name of the material which they are to carry, and also the shop to which they belong. The object of this marking of the cans is so that different materials will not be put in the same can. It causes very serious difficulty if a sample, for example, of 150° burning oil is put into a can which has previously carried well oil, since the color is affected by any remnants of the well oil which might be left in the can, and the color of 150° burning oil is one of the items covered in the specifications. The same thing—namely, contamination of the sample with some of a previous shipment, applies in all cases. Of course cans can be properly cleaned, and cleaning is always made use of, but it is better and avoids much chance for doubt if a can is used only to carry one kind of material. The cans, for the purpose of transportation, are put in small wooden boxes, fitted usually with rope bails. These boxes close with a hasp and staple, and are marked on the top with the following words: "Sample for Test—to be forwarded on Passenger Trains, by Railroad Service. Return to ..... Shop." In some cases, in place of the words "Sample for Test" the name of the kind of material for test is put on. This is determined by the shops themselves. When the can is coming to the Laboratory, a tag is tied to the staple, and the train people forward the cans as per the tags, it being understood by all the train service that any boxes or packages marked with tags come as per the tags. These boxes and the sample cans are returned to the shops as soon as we have finished with them. The necessary marking for this purpose is on the top of the box. We of course remove the tag from the staple. The boxes are large enough to hold the sample can, and are made as small and light as possible, so that the train men may handle a good many of them at once. The rope bails facilitate the grasping of a number of them in the hand at one time. If the material is dry, it may be sent in a paper package, having one of the sample for test tags, or in many cases, as for instance, sulphate of copper, sal ammoniac, and other powders, it may be put into one of the little boxes above described. In the case of spring steel and metals, generally a package is made, or special boxes are provided for the purpose, with partitions holding a number of samples, and which have a special bail so that it can be easily handled by the train men. It is not advisable to put metals in a paper package with the tags attached to each sample, since it frequently happens that the rubbing together during transit interferes with the tags.

The "Sample for Test" tag is a matter of some importance, and a copy of the same is given below.

(FRONT OF TAG.)

SAMPLE FOR TEST
From .....

PENNSYLVANIA RAILROAD COMPANY.

Care of

CHARLES B. DUDLEY,

Chemist,

Altoona, Pa.

(BACK OF TAG.)

Amt... ..... *Rec'd*... .....

Kind, ...

From .....

Price, ...

Req. No.....

It will be observed that on one side are the directions for the shipment, along with the words "Sample for Test," and the shop from which it is sent. On the other side are the amount of material, the date when received, the kind of material, the shipper, the price and the requisition number. All this information should accompany every sample—part of it as a means of identification when the Test Report is sent, and part of it for our records—which information is subsequently used in making out the annual report of the operations of the Laboratory.

The length of time after a shipment arrives at its destination before it can be used varies with different materials. At the more distant shops it takes, perhaps, 24 to 36 hours after the shipment arrives for the sample to be taken, and for this to reach the Laboratory. It takes a varying amount of time, depending on the nature of the material, for the Laboratory to do its work. Many samples are tested and reported the same day as received. This is especially true of oils, the tests of which are capable of rapid application. In some cases, such as phosphor-bronze and some metals, the different tests of which re-

quire either longer time or the number of tests is so great that they cannot be gotten through with in one day, the report passes over to the next day. After the test is finished and the report made, as is described below, it takes a day, or possibly a day and a half, for the report to pass through the offices and reach the shop for which it is designed. It will thus be seen that with many materials there is a chance at the more distant shops of from four to five days intervening between the arrival of the shipment and the receipt of the report of test, ready for use. This delay has never caused very serious difficulty, simply because this time is allowed for in making requisitions for materials. Many of the current supplies are bought by the purchasing agents once a month, and the requisitions are put in in such time as to allow for the necessary delays of placing the order with the manufacturer, for him to fill the order, for the material to be shipped to the place required, and the necessary time for the testing. In certain cases, as above described, the sampling is done at the works. This is especially true of springs and phosphor-bronze shipments; and it is fairly possible that the system of sampling before shipment may be extended quite considerably as time progresses. One of the advantages of this method of sampling is that the time while the material is on the road can be utilized by the Laboratory in making the necessary test, since the sample representing the shipment goes by passenger train, while the shipment is carried at a much slower rate on freight train, and it not infrequently happens with some materials, that the report of test and the shipment arrive at the distant shop at practically the same time.

Some questions may arise as to the advisibility of the three regulations which have been spoken of as being enforced in every case in taking the sample. The reason why we have a Company representative take the sample is entirely obvious. It is not so much that we distrust the parties who furnish the materials, as because we must know from our own knowledge that the sample fairly represents the material, and no fair-minded person would object to this method of procedure. A doubt anywhere in the chain from the taking the sample to the final payment of the bill makes all the rest of the work worthless.

At this point the query may naturally arise, whether, in our experience, there has been discovered any tampering with the men who take the samples or with the inspectors at the works. We will only say upon this point, that during the last seventeen years two or three men who did this work no longer work for the Company. The number of cases of men who have fallen under suspicion, and in which it has been possible to locate the fault on them, has been perhaps as small as could be expected in a large service. It would be too much, of course, to say that false sampling has not taken place, but the system of checks in force on the Pennsylvania Railroad is of such a nature that it would be difficult for any one for any period of time to carry on anything of this kind. One of these checks upon which we rely is this—namely, if inferior material is accepted, owing to the Laboratory having been furnished with a doctored sample, it is almost sure to result that some difficulty will arise in the service, and when this does occur the Laboratory usually hears from it, as it is quite common for all who have had to do with this lot of supplies to say that the material was tested and approved of at the Laboratory. As soon as we hear from it we ask for a portion of the very material which has given difficulty, and then a comparison is made of the sample giving difficulty with the original sample sent us, which gives us a means of checking up the uniformity of the shipment. If the discrepancy seems to warrant such action, we immediately institute an investigation in regard to the sampling.

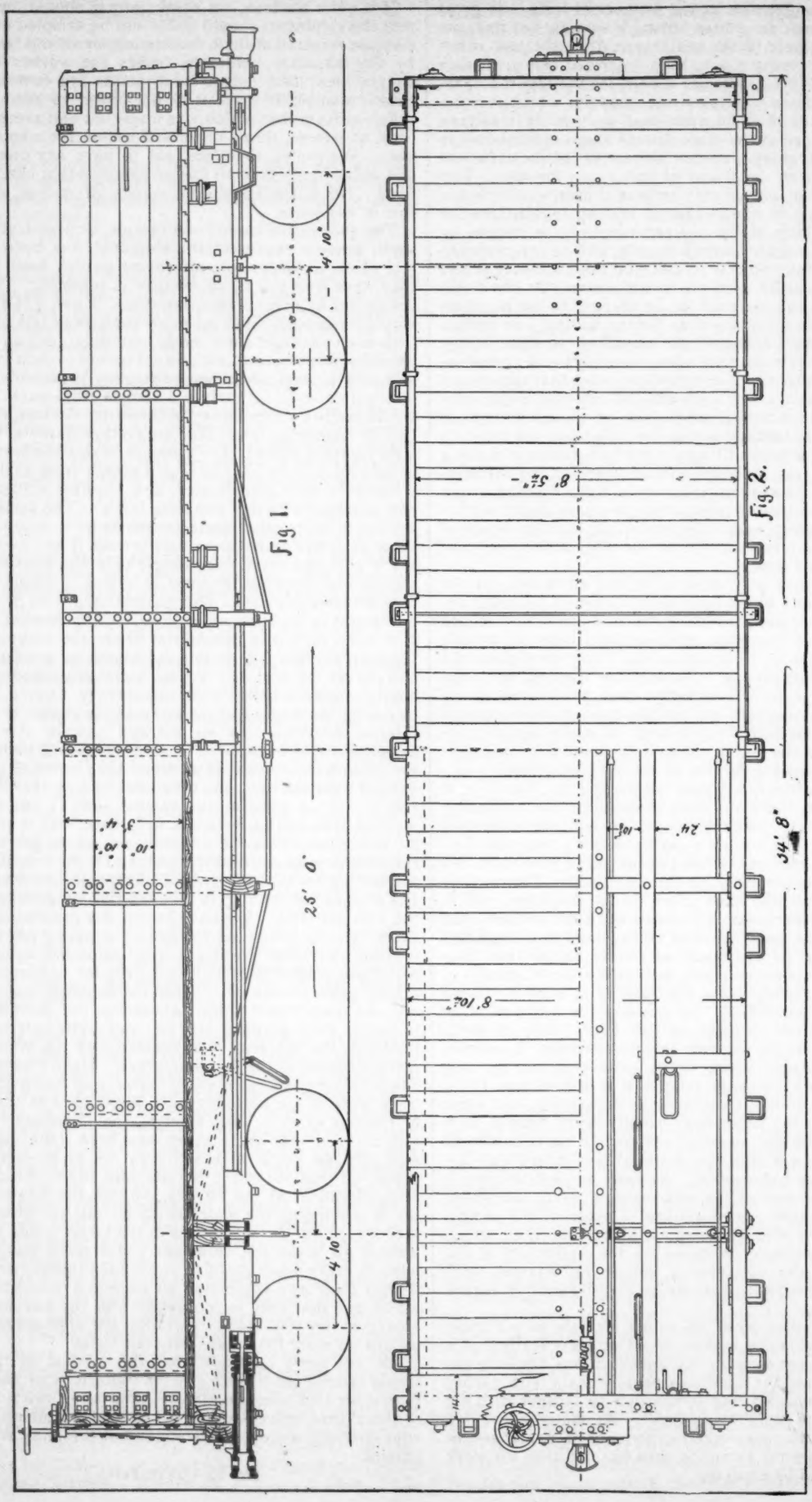
There is another point on which we rely to a certain extent, and that is the honest manufacturers really find it to their advantage to have the specifications honestly enforced, and since the Company usually deals with parties of the best reputation, the temptation to tamper with the men who do the sampling is small. As stated above, we know of only two cases in our experience of nearly seventeen years where the sampling man has not done his work as well as could be expected.

It is quite obvious, we think, why it should be insisted that the shipments should either not be sampled until after they are received at their destination, or should be sampled by the inspector before he leaves the works. It is, of course, clear that unless these points are covered, a dishonest man would have it in his power to send material different from that which was inspected and sampled, and thus, of course, throw uncertainty upon the whole inspection. We prefer, therefore, not to have any doubt arise, and accordingly take all the precautions that can be fairly used. No fair-minded man would, of course, object to this in any sense.

The question of having one sample, or practically a very small amount represent the shipment, has been the subject of some discussion, and some parties have felt that they were wronged by so meagre a sampling. We were led to this by several considerations. First, it is obvious it would be impossible to make an analysis or test of sample from each package, since many materials, such as springs, phosphor-bronze, zinc., etc., do not permit of such sampling, and also in cases where such sampling is possible, as with oils, paints, etc., to analyze a sample from each package would require a small army of chemists. Second, the question of sampling, if we take an average sample, becomes a very serious matter. For example, take a hundred barrels of lard oil. If we have to take a sample from each barrel, it becomes very complicated, and requires skilled or expert persons to do this sampling fairly. The same remark applies to every other material whatever it may be. The labor of sampling becomes very serious if we must sample every package. We accordingly carefully considered the question of the risks involved in taking a single sample. Our reasoning is this. The material ought to be all alike and ought to all fill specifications, for this is what we buy. If it does, then it is immaterial where the sample comes from; if it does not do this, no one is so anxious to find this out as we are. Looked at from this standpoint, the single sample is better than the average sample, because by taking the single sample we stand the chance of striking inferior material. In an average sample the inferior material would be masked by that which was better. We are quite well aware that we stand the chance of getting a sample from the best, and then later finding that the material is not as good as the sample shows; but with our method of sampling, which is fully described in the circular above, we think we are fully as apt to get a sample from the poorest as from the best, and if the manufacturers are willing to take the risk of our getting hold of a poor sample, we are willing to take the risk of getting hold of the best material. We have had in our experience two or three cases in which our method of sampling has detected inferior materials. A single illustration will suffice. An order was placed with a certain firm for 50 barrels of the second grade of lard oil. When the shipment was received and the sample sent to the Laboratory, the sample proved to be the third grade of lard oil, and quite inferior. Accordingly the material was rejected and the whole shipment returned to the manufacturers. Upon receipt of the shipment, they sampled every barrel, and found that 47 of them were of the correct grade, while three of them were of inferior grade. They went to the Purchasing Agent, and claimed that an injustice had been done them, and said that we ought to have taken the 47 barrels. They explained that the three barrels had been added by the Superintendent at the factory, without the knowledge of the firm shipping the material, to fill out the order, as he lacked that number of barrels of the better grade when he wanted to make the shipment. Our reply was that we were in every sense gratified at the turn things had taken; that by their own confession an attempt at fraud had been made, and that they were caught, and the punishment of having to pay the return freight for the annoyance caused us was no more than was justly due them.

We are quite confident that the method of taking a single sample insures us greater uniformity of shipments than if we took average samples, and after now a number of years' experience we have yet to find any manufacturer who seriously objects to the method of sampling which we pursue.

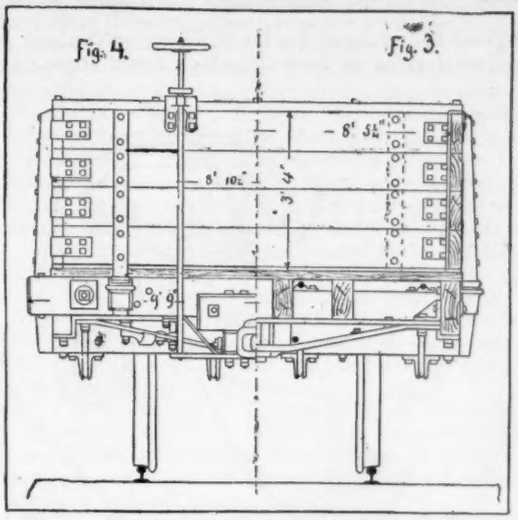
(TO BE CONTINUED.)



STANDARD COAL CAR, 60,000 LBS. CAPACITY, FOR MISSOURI PACIFIC RAILWAY.

MISSOURI PACIFIC STANDARD COAL CAR.

THE accompanying drawings show the standard coal and flat car adopted by the Missouri Pacific Railroad Company. The car is shown with the siding on for coal, and as thus arranged it has a capacity of 60,000 lbs. The general dimensions are: Length of box, 34 ft. 8 in.; length between outside ends of draw-bars, 37 ft. 4 in.; width over

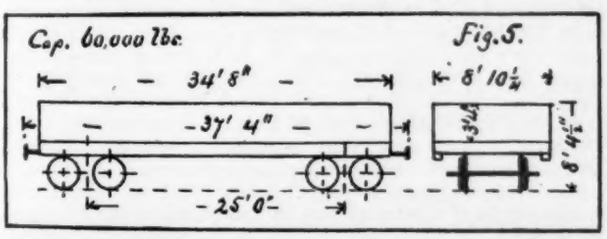


all, 8 ft. 10¼ in.; width inside of box, 8 ft. 5 in.; height from rail to top of box, 8 ft. 1½ in.

The trucks are spaced 25 ft. between centers. They are of the standard adopted for all the freight equipment of the road, and have four 33-in. wheels; the axles are 4 ft. 10 in. between centers.

The drawings show in fig. 1 a side elevation of one-half the length of the car and a section of the other half; in fig. 2 a plan, with the flooring partly removed to show the framing; in fig. 3 a cross-section, and in fig. 4 an end view. Fig. 5 gives the general dimensions.

The trucks will be described and illustrated hereafter. The drawings show so plainly the method of construction of the car body that but little description is required, and it is only necessary to say that the lumber used throughout is of the best quality, while the proportions adopted for the different parts have been given them after careful study of the results of experience. The castings and wrought-



iron work are made as nearly as possible uniform for all the different classes of freight cars on the road.

The design of these cars is due to Mr. Frank Rearden, Superintendent of the Locomotive and Car Department of the road, who had extensive practical experience on the Union Pacific and in charge of several divisions of the Missouri Pacific before his promotion to his present position. The rolling stock of the road is now in better condition than ever before, and its records for the past year show a very low proportion of "bad order" cars.

BRAKE TESTS.

A MEETING of the Committee—Messrs. G. W. Rhodes, E. B. Wall, and George Gibbs—appointed by the Master Car Builders' Association to report at the June annual convention on a standard of efficiency to which all power brakes shall be subjected before they receive the indorsement of the Association, was held at Chicago, March 25, all members being present.

The following specification was prepared and submitted to brake manufacturers and others interested in safety appliances for criticism:

1. Brakes will be tested on either a 50-car train of 34-ft. cars, or on a rack representing the piping of a 50-car train. In the latter case, special effort must be made to have all cocks, screens, angles, and connections identical with those in train service. A drawing will be submitted, showing what shall constitute the proper fittings, pipe, etc., for one car, including engine connections to the pilot.

2. *Pressure.*—Tests will be made with a uniform train-pipe pressure of 70 lbs.

3. *Piston Travel.*—In testing brakes the piston travel must be so adjusted that it will not be less than 6 in. or more than 7 in.

4. *Construction of Triples.*—Triples must be constructed so that they can be secured and operated on apparatus conforming to diagram, fig. 1. (The Committee will publish this diagram at a later date, or will furnish it immediately to any brake company requesting it.)

5. *Application Test No.* 1.—Brakes must commence to apply on the fiftieth car in 3 seconds, or less than 3 seconds, from the moment of first application on the engine, and must indicate at least 55 lbs. in the cylinder in 3½ seconds or less from the initial application.

6. *Application Test No.* 2.—Commencing with the fifth car from the engine, the air from the cylinders of three successive cars will be cut out. The brakes will then be applied as per test No. 5, and if they fail to make the time stipulated on the fiftieth car, the brake will not be considered as coming within the Association's requirements.

7. *Release Test No.* 1.—A uniform pressure of 70 lbs. having been secured in the train-pipe, all the air will be exhausted from the train-pipe. After a pause of 10 seconds, to allow the equalization of the auxiliary and cylinder pressure, the train-pipe will be pumped up to a pressure of 63 lbs., and the record of the condition of the brakes taken. All brakes that are found applied at this pressure will be considered as not releasing.

8. *Release Test No.* 2.—This test will be arranged the same as in No. 7, except in the release. In place of pumping the pressure off, 90 lbs. will be accumulated in the main air reservoir and turned into the train-pipe. After a period of 6 seconds, at which time all brakes should be released, the record will be taken as before.

9. To insure the accuracy of the measurements of time in application and release electrical recording apparatus will be used.

The Committee adjourned, to meet at the Grand Pacific, Chicago, on April 22, 1892, at which time representatives from the various brake companies and others interested were invited to be present and discuss the above tests.

A DISCUSSION OF THE POSSIBILITIES OF THE M. C. B. COUPLER.

BY EDWARD P. EASTWICK, JR., C.E.

(*Concluded from page* 169.)

IN the foregoing exemplification the effect of frictional resistance has been neglected, and it has been assumed that the force acting on the lock, caused by a pulling force, is perpendicular to its bearing surface; but in reality the force on the lock does not act strictly in this manner. Its line of action is in a direction which is the resultant of the perpendicular force and the frictional resistance thereby produced. If ξ is the coefficient of friction, then ξ multiplied by the vertical force on the lock equals the frictional resistance, and the greatest force acting on the lock is the resultant of these two forces.

The force acting on the lock, as also that on the pivotal pin, under these conditions may be either graphically or analytically determined; and as the matter involved is of great practical importance to the economical designing of a coupler, both methods will be given.

Let *A B C D*, in fig. 10, be the parallelogram of forces

as laid off in fig. 7, the force at the locking pin being taken perpendicular to the bearing surface.

From F lay off $F\ I$ equal to $A\ B$ (the perpendicular force), and from I draw $I\ T$ parallel to the bearing face of the lock to represent the frictional resistance (equal to

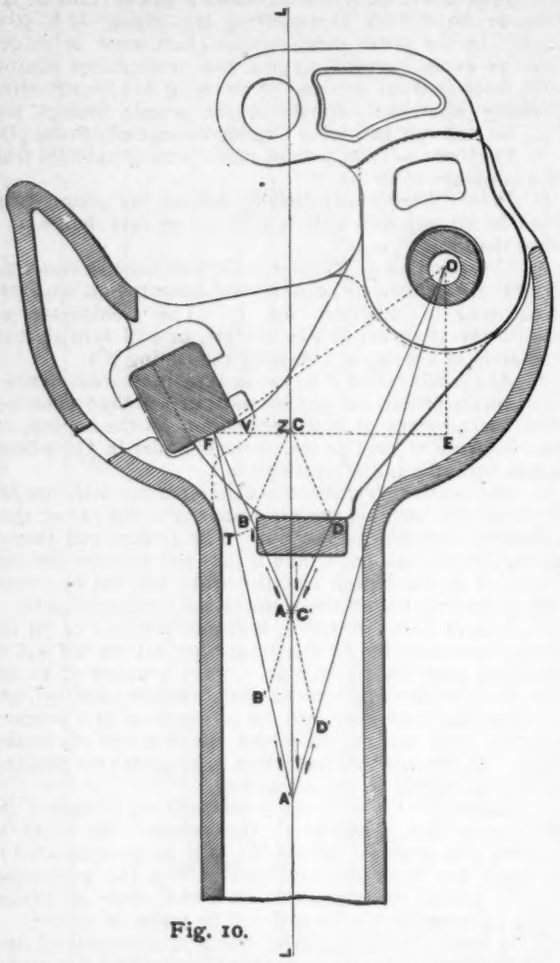


Fig. 10.

$\xi \times A\ B$). Then a line drawn from F through T gives the direction of the resultant, and the intensity of this force may at once be determined by forming the second parallelogram of forces $A\ B\ C\ D$ in the manner as before explained. This constitutes the graphical method.

Analytically the forces acting on the lock and pivotal pin may be determined as follows:

First, neglecting the frictional resistance of the lock, let the angle $V\ F\ E$, which the bearing face of the lock makes with a line drawn from the point F perpendicular to the center line $L\ L$, be given also $F\ Z$, $Z\ E$ and $O\ E$, then

$$F\ O = \sqrt{O\ E^2 + (F\ Z + Z\ E)^2} \text{ and } \operatorname{Sin} O\ F\ E = \frac{O\ E}{O\ F}.$$

In the triangle $O\ F\ A$ the angle

$$O\ F\ A = 90^\circ + V\ F\ O$$
$$V\ F\ O = O\ F\ E - V\ F\ E$$
$$\therefore O\ F\ A = 90^\circ + O\ F\ E - V\ F\ E.$$

From the triangle $F\ A\ Z$ we get

$$F\ A = \frac{F\ Z}{\operatorname{Sin} F\ A\ Z}$$

and $F\ A\ Z = F\ A\ C = V\ F\ E$.

The angle $F\ A\ O$ may now be found. In the triangle $F\ A\ O$

$$(F\ O + F\ A) : (F\ O - F\ A) = \tan \tfrac{1}{2}(F\ A\ O + F\ O\ A) : \tan \tfrac{1}{2}(F\ A\ O - F\ O\ A)$$
$$\tfrac{1}{2}(F\ A\ O + F\ O\ A) = \tfrac{1}{2}(180^\circ - O\ F\ A). \qquad (a)$$

All other quantities entering the equation (a) being known, the value of $\frac{1}{2}(F\ A\ O - F\ O\ A)$ is at once determined, and

$$F\ A\ O = \tfrac{1}{2}(F\ A\ O + F\ O\ A) + \tfrac{1}{2}(F\ A\ O - F\ O\ A),$$

and $C\ A\ O = F\ A\ O - F\ A\ Z$.

In the triangle $A\ B\ C$, the angles

$$A\ B\ C = 180^\circ - (B\ A\ C + B\ C\ A)$$
$$B\ C\ A = C\ A\ O, \text{ and } B\ A\ C = F\ A\ C.$$

$$\left.\begin{aligned} A\ B &= \frac{\operatorname{Sin} B\ C\ A}{\operatorname{Sin} A\ B\ C} \times C\ A \\ A\ D &= \frac{\operatorname{Sin} B\ A\ C}{\operatorname{Sin} A\ B\ C} \times C\ A \end{aligned}\right\} \text{I.}$$

I gives the values of the forces acting on the lock and at the pivotal point of knuckle, which result from a pulling

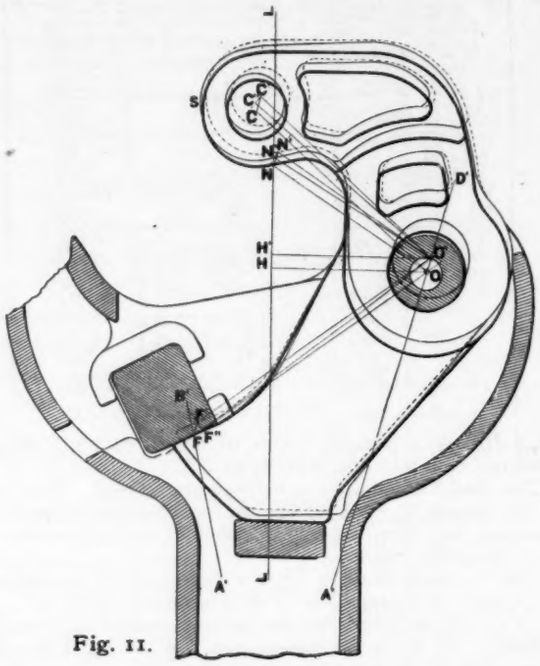


Fig. 11.

force, $A\ C$, when frictional resistance at the bearing surface of lock is neglected.

If, however, the coefficient of friction equals ξ, the frictional resistance at the bearing face of the lock equals $(\xi \times A\ B)$, and the resultant force at the lock acts in the direction $A'\ F$ and $\tan A\ F\ A' = \dfrac{\xi \times A\ B}{A\ B}$, from which the angle $A\ F\ A'$ is determined.

In the triangle $F\ A\ A'$ the angle

$$F\ A\ A' = 180^\circ - F\ A\ C$$
and $F\ A'\ A = 180^\circ - (F\ A\ A' + A\ F\ A') = F\ A'\ Z$.

From the triangle $F\ A'\ Z$ we get

$$F\ A' = \frac{F\ Z}{\operatorname{Sin} F\ A'\ Z}.$$

The angle $F\ A'\ O$ may now be found, for in the triangle $F\ A'\ O$

$$(F\ A' + F\ O) : (F\ A' - F\ O) = \tan \tfrac{1}{2}(F\ O\ A' + F\ A'\ O) : \tan \tfrac{1}{2}(F\ O\ A' - F\ A'\ O) \quad (b)$$
$$\tfrac{1}{2}(F\ O\ A' + F\ A'\ O) = \tfrac{1}{2}(180^\circ - O\ F\ A') = \tfrac{1}{2}(180^\circ - (O\ F\ A + A\ F\ A').$$

All other quantities entering the equation (b) being known, the value of $\frac{1}{2}(F\ O\ A' - F\ A'\ O)$ may be determined, and

$$F\ A'\ O = \tfrac{1}{2}(B\ O\ A' + F\ A'\ O) - \tfrac{1}{2}(F'\ O\ A' - F\ A'\ O)$$
and $C\ A'\ O = F\ A'\ O - F\ A'\ Z$.

In the triangle $A'\ B\ C'$ the angles

$$A'\ B\ C' = 180^\circ - (B'\ A'\ C' + B\ C'\ A')$$
$$B\ C'\ A' = C'\ A'\ D', \text{ and } B\ A'\ C' = F\ A'\ Z.$$

$$\left.\begin{aligned} A'\ B &= \frac{\operatorname{Sin} B\ C'\ A'}{\operatorname{Sin} A'\ B\ C'} \times C'\ A' \ * \\ A'\ D' &= \frac{\operatorname{Sin} B\ A'\ C'}{\operatorname{Sin} A'\ B\ C'} \times C'\ A' \end{aligned}\right\} \text{II.}$$

* $C\ A = C'\ A'$.

Knowing the proper value of the coefficient of friction, the true value of the intensities of the forces acting at the lock and pivotal point of knuckle caused by any pulling force may be found from II, and these being known, the different parts of the coupler may be properly proportioned to withstand the strains.

The forces resulting from buffing may also, in a similar manner, be analytically determined; but as the demonstration differs little from that given for a pulling force, it will be unnecessary to consider it further.

In conclusion, it may be of interest to investigate more fully the effects of wear in different constructions of the M. C. B. coupler, and to determine more accurately than has heretofore been done results which have been only imperfectly explained. Lost motion developed at the lock and pivotal point of the knuckle is, in its evil effect, in many cases the sole cause of couplers pulling apart after being in use only a very short time; but this is a fault, as already observed, which to a great extent is remediable.

Take, for illustration, the form of coupler shown in figs. 10 and 11, which are more detailed drawings of that given in fig. 7, and let us first determine for this case the effect produced at the coupling face of the knuckle by a wear at the lock or pivotal pin. Formulæ may then be obtained applicable to all designs of couplers.

In fig. 11 draw the line $A' B'$ parallel to $A' B'$ in fig. 10, and $A' D'$ parallel to $A' D'$. The wear on the pivotal pin then occurs approximately in the direction of this latter line, and lost motion is taken up in the same direction. This will soon be made clear.

To find the effect of wear at the lock and pivotal pin, it is first necessary to fully comprehend the general results produced by wear at each of the points separately, and afterward the combined effect of the two, in reference to the outward movement of the coupling face of the knuckle, may be easily determined.

To commence with, take the effect of wear at the pivotal pin, and say, for example, the *heavy* full lines in fig. 11 represent the normal or proper position of the knuckle, the center of the pivotal pin being at O. Now let the wear be sufficient to allow the center of revolution of the knuckle to move to the position O' on the line $A' D'$. If then a pulling force is brought to bear at N, and for the moment we suppose the locking pin replaced by a force equal to and acting in the direction of the total resistance offered by the lock, the position of equilibrium for the knuckle is that indicated by the dotted lines.*

The point F will move to F', the point N to N', and the point C to C'. As there has been no wear at the lock, however, the true position for F will be F''; that is, at the intersection of an arc of a circle described from O' and having the radius $O' F'$ (equal to $O F$), with the locking face of the knuckle. This is not strictly true, for it would only be so if the lock were a point. But the lock has a bearing surface, and the shank of the knuckle in the last position would therefore strike first on that point of the surface nearest the center of revolution of the knuckle (the corner of the locking pin in the present case). Consequently the point F'' is drawn in farther than has been assumed. However, as the angle $F' O' F''$ (equal to $O' F O$) is always small for any allowable wear (except in the case where the distance of the lock from the pivotal point is very small, as represented in fig. 6, which is evidently so defective a construction as to be unworthy of consideration), and as the change of position of the point of application of the force on the lock is never very great (so that the bearing surface of the shank of the knuckle in the last position closely corresponds with the normal position), it is at once seen that the assumption made is nearly correct and sufficiently accurate for any practical purpose. The point N, therefore, assumes the position N'' and the point C the position C'' located on the arc described from O' as a center and having the radius $O' N'$ (equal to $O N$), the angle $N' O' N''$ being equal to the angle $F' O' F''$, and the final position of the knuckle resulting from the wear $O O'$ at the pivotal pin is that indicated in fig. 11 by the *light* full lines.

Thus the general effect of wear at the pivotal pin is determined, and the effect of wear at the lock alone has incidentally been shown in the foregoing demonstration. The combined effect of wear at the two points is also apparent, for it is evident that the dotted line in fig. 11 corresponds with the position of the knuckle resulting from the wear $O O'$ at the pivotal pin and a wear at the lock, perpendicular to its bearing surface, equal to $O O' \times \text{Sin } \phi$ ($\phi = F' F F''$).

The amount of outward movement at the coupling face of the knuckle caused by a given wear at either the lock, the pivotal pin, or both, may readily be determined, and the general formulæ applicable to this and all other cases will now be deduced.

If the standard M. C. B. contour lines are used, it will be seen from inspection of them (fig. 12) that it is necessary to determine the position of only one point, for knowing the position of this point, the position of the nose of the knuckle is also known, and on the position of the nose of the knuckle the possibility of two couplers pulling apart is dependent. The point referred to is at C—*i.e.*, the center from which the arc is described, which forms the contour of the nose of the knuckle, and its position should be known in reference to the line $A B$ (or one parallel at a known distance) and the center line $L L$. The distance which the point is from the line $A B$ determines the amount of the outward movement of the coupling face of the knuckle, and thus the lateral movement of which the coupler is capable. The distance from the line $L L$ determines the amount of lateral movement required before the knuckles of two locked couplers can pass one another.

The lateral movement of the couplers increases with the distance of the point C (hence the coupling face of the knuckle) from the line $A B$, and the amount of lateral movement necessary for the knuckles to pass increases with the distance of the point C from the center line. *Hence it is desirable, in coupler construction, that the effect of wear on the lock and pivotal pin shall result in the least outward movement of the point C with relation to A B, and the greatest outward movement with relation to L L.*

Referring to fig. 11, let the wear on the pivotal pin in the direction $A' O$ be represented by $O O'$ (equal to κ), and to avoid confusion by too many lines, let the demonstration now be transferred to fig. 13, in which similar letters indicate similar points and lines in both figures. The directions of the lines have been slightly altered so as to make the latter figure more clear. Thus in fig. 13 F is the point of application of the force at the lock when no wear has taken place, or, in other words, when the knuckle is in its normal position. F' is the position of the same point, when, as before, a force equivalent to the resistance offered by the lock is substituted for the lock, and F'' is the final or true position of the same point resulting from a wear, $O O'$, at the pivotal pin alone. O and O' are taken the same as in fig. 11, and C, C' and C'' are the several positions of the corresponding point in the same figure. N, N' and N'' and the lines $N O$, $N O'$ and $N O'$ are omitted.

Draw the dotted lines $H O$ and $V O'$ both perpendicular to $L L$, and $C H$, $C' H'$ and $C'' H''$ parallel to the same line. Also extend the bearing face of the lock $F X'$, and draw the dotted lines $O X$ and $O' X'$ perpendicular to it.

Given the following dimensions:

$$F X = L \qquad O H = H$$
$$O X = T \qquad C H = P$$
$$\text{and angle } F'' F Y = \beta.$$

The angle $F F F''$ has been calculated. $R = \sqrt{L^2 + T^2}$, and $r = \sqrt{H^2 + P^2}$.

* It will readily be understood that if the center of revolution of the knuckle is always on the line $A' D'$, the force acting on the lock (which is considered to act at the center point of the bearing surface) will vary both in direction and intensity for every change of position of the point of revolution of the knuckle. But as it has previously been shown that the lock is only capable of resisting a force in a direction which is the resultant of the normal force and frictional resistance, the assumption that the force at the pivotal pin always acts in the direction of the line $A' D'$ is not strictly correct. In fact, the direction of the force is constantly changing, and the wear at the pin and path of the center of revolution would be a curve tangent to the line $A' D'$ at O. However, as this is not intended to be an *exact* mathematical determination, and as the angle which the line $A' D'$ makes with $L L$ is always small in properly constructed couplers, it will be admissible and sufficiently accurate for all practicable purposes to consider $A' D'$ as the direction of movement of O up to the allowable wear on the knuckle or pivotal pin.

$$\text{Sin } O\,F\,X = \frac{T}{R} \text{ and } \cos\, O\,F\,X = \frac{L}{R},$$

$$\text{Sin } O'\,F''\,X' = \frac{T + \kappa \sin \phi}{R} \text{ and}$$

$$\text{Cos } O'\,F''\,X' = \frac{\sqrt{R^2 - (T + \kappa \sin \phi)^2}}{R}.$$

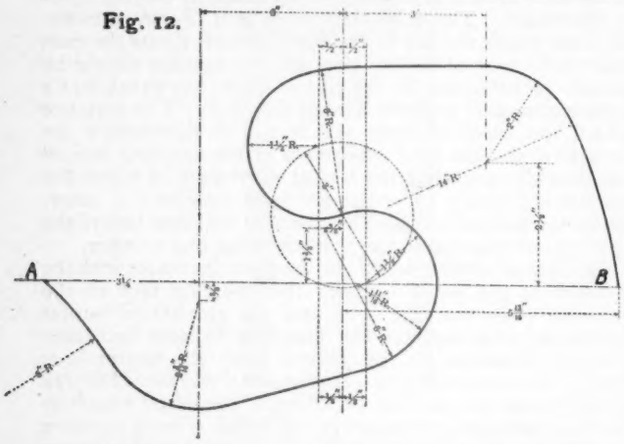
The angle $F'\,O'\,F'' = O'\,F''\,X - O\,F\,X$, and if this angle is represented by a, it follows from the general formulæ for the sine and cosine of the difference of two angles:

$$\left.\begin{aligned} \text{Sin } a &= \frac{(T + \kappa \sin \phi)\,L}{R^2} - \frac{\sqrt{R^2 - (T + \kappa \sin \phi)^2}\,T}{R^2} \\ \text{Cos } a &= \frac{\sqrt{R^2 - (T + \kappa \sin \phi)^2}\,L}{R^2} + \frac{(T + \kappa \sin \phi)\,T}{R^2} \\ {}^{*}\kappa &= \frac{\sqrt{R^2 - (L \cos a - T \sin a)^2} - T}{\text{Sin } \phi}. \end{aligned}\right\} \text{III.}$$

From III. the value of a may be calculated for any wear κ at the pivotal pin, and since the angle $F'\,O'\,F''$ equals the angle $C'\,O\,C''$ (as may be seen by inspection of fig. 13), the value of a thus found determines the position of *C for wear at the pivotal pin alone.*

Formulæ III. are general, and applicable to all cases, but it must be remembered that the angle ϕ is always measured

Fig. 12.



from the normal position of the bearing face of the lock in a direction contrary to the hands of a clock, and that the angle a is measured in the same direction from the line $O\,F$ in its position $O'\,F'$.

If in III. a vertical wear at the lock equal to $-\kappa_1$ is substituted for $\kappa \sin \phi$ —

$$\left.\begin{aligned} \text{Sin } a_1 &= \frac{(T - \kappa_1)\,L}{R^2} - \frac{\sqrt{R^2 - (T - \kappa_1)^2}\,T}{R^2} \\ \text{Cos } a_1 &= \frac{\sqrt{R^2 - (T - \kappa_1)^2}\,L}{R^2} + \frac{(T - \kappa_1)\,T}{R^2} \end{aligned}\right\} \text{IV.}$$

from which the position of the point C may be determined for wear at the lock alone.

If there is a wear equal to κ at the pivotal pin and a perpendicular wear equal to κ_1 at the lock, the point F will take a position, F'''', on the arc described from O' as a center between F' and F'' (F'''' is not shown in figure), and if the angle $F''''\,O'\,F$ is represented by a_{11}, then

$$\left.\begin{aligned} \text{Sin } a_{11} &= \frac{(T - \kappa_1 + \kappa \sin \phi)}{R^2} L - \frac{\sqrt{R^2 - (T - \kappa_1 + \kappa \sin \phi)^2}}{R^2} T, \\ \text{Cos } a_{11} &= \frac{\sqrt{R^2 (T - \kappa_1 + \kappa \sin \phi)^2}}{R^2} L + \frac{(T - \kappa_1 + \kappa \sin \phi)}{R^2} T, \end{aligned}\right\} \text{V.}$$

* $\text{Sin } F'\,O'\,X' = \cos\, O'\,F'\,X' = \dfrac{\sqrt{R^2 - (T + \kappa \sin \phi)^2}}{R}$

$$\text{Sin } F'\,O'\,X' = \sin\,(F\,O\,X - a) = \frac{L}{R} \cos a - \frac{T}{R} \sin a.$$

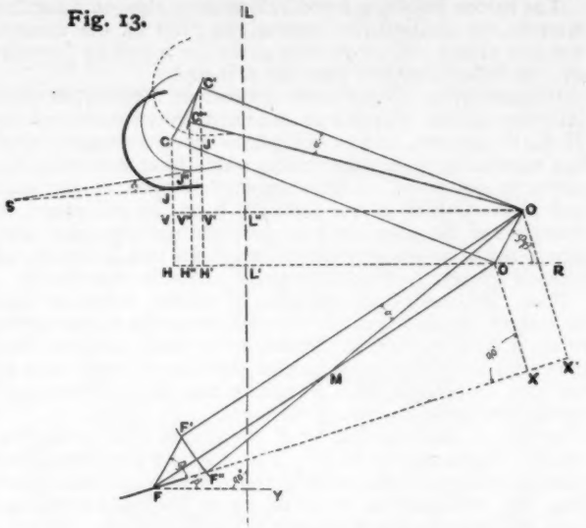
Equating and solving for κ, we get:

$$\kappa = \frac{\sqrt{R^2 - (L \cos a - P \sin a)^2} - T}{\text{Sin } \phi}.$$

The position of the point C is, as before explained, located with reference to the center line $L\,L$ and the line $H\,O$ at a known distance, d, and parallel to $A\,B$ (fig. 12).

Let H' and P be the vertical distances of the point C from $L\,L$ and $H\,O$, respectively, when the knuckle is in its normal position, and let x and y represent similar distances

Fig. 13.



of the point C when the knuckle has assumed the position caused by a wear, κ, at the pivotal pin, or a perpendicular wear, κ_1 at the lock, or both. The angle $C'\,O\,V$ equals the angle $C\,O\,H$ from construction.

Now if in fig. 13 the angle $C'\,O'\,C''$ is made equal to a_{11} so that C'' is the position of C resulting from wear κ at the pivotal pin, and a perpendicular wear, κ_1 at the lock, we obtain:

$$C''\,V'' = r \sin\,(C'\,O'\,V' - a_{11}) = P \cos a_{11} - H \sin a_{11}$$
$$V''\,O' = r \cos\,(C'\,O'\,V' - a_{11}) = H \cos a_{11} + P \sin a_{11}$$

and

$$\left.\begin{aligned} y &= P \cos a_{11} - H \sin a_{11} + \kappa \sin\,(\phi + \beta) \\ x &= H \cos a_{11} + P \sin a_{11} + H' - H - \kappa \cos\,(\phi + \beta) \end{aligned}\right\} \text{VI.}$$

VI. gives the position of C relative to the lines $H\,O$ and $L\,L$, for a wear of κ and κ_1 at the pivotal pin and lock, respectively, a_{11} being calculated by V.

If in V. κ equals zero and consequently a_{11} equals a_1 (vide IV.) the formulæ become:

$$\left.\begin{aligned} y_1 &= P \cos a_1 - H \sin a_1 \\ x_1 &= H \cos a_1 + P \sin a_1 + H' - H, \end{aligned}\right\} \text{VII.}$$

which gives the position of C for a wear of κ_1 *at the lock alone.*

If in V. κ_1 equals zero and consequently a_{11} equals a (vide III.) the formulas become:

$$\left.\begin{aligned} y_{11} &= P \cos a - H \sin a + \kappa \sin\,(\phi + \beta) \\ x_{11} &= H \cos a + P \sin a + H' - H - \kappa \cos\,(\phi + \beta), \end{aligned}\right\} \text{VIII.}$$

which gives the position of C for a wear of κ *at the pivotal pin alone.*

It will be seen from III. that the angle a decreases with the angle ϕ, and that when this latter becomes zero a also becomes zero, and from VIII.

$$y_{111} = P + \kappa \sin \beta$$
$$x_{111} = H' - \kappa \cos \beta.$$

This case is represented in fig. 4.

If the angle ϕ becomes minus, a is also minus, and

$$y_{IV} = P \cos\,(-a) - H \sin\,(-a) + \kappa \sin\,(-\phi + \beta)$$
$$= P \cos a + H \sin a + \kappa \sin\,(\beta - \phi),$$

and

$$x_{IV} = H \cos a - P \sin a + H' - H'' - \kappa \sin\,(\beta - \phi),$$

which shows that the point C is caused to move out a greater distance and approach the line $L\,L$ for the same wear at the pivotal pin. This case is represented in fig. 1.

Again, the value of a increases with the angle ϕ, and y

becomes a minimum when ϕ equals $+ 90°$; a also increases as R decreases, and hence the minimum value for y and maximum value for x for wear at the *pivotal* pin alone occur when

$$\phi = + 90°$$
$$\text{and } R = \text{minimum.}$$

But the minimum value for y and maximum value for x for wear at the *lock* alone occur when the bearing face of the lock corresponds with a radial line from the center of revolution and when R is a maximum.

Therefore, bearing in mind that the wear at the lock and pivotal pin is proportional to the forces acting at these points, it would seem that the most advantageous construction of the M. C. B. coupler would be reached when the angle ϕ were made equal to $+ 90°$, while at the same time the direction of the bearing face of the lock corresponded with the radial line from the center of revolution, and R and r had such relative values that the total strain on the lock and pivotal pin was equalized and a minimum.

AN IRON AND OAK PAVEMENT.

(Extract from paper read before the American Society of Mechanical Engineers, by J. Wendell Cole, of Columbus, O.)

THE desideratum for the best pavement appears to be one which would give a good and safe foothold to the horse, which would afford a good surface for traffic, and which would be durable. One which could combine lack of noise with these other advantages would appear to be well in the front rank for meeting the requirements of to-day.

There is a small piece of pavement 9 ft. × 27 ft. 4 in, in Columbus, O., at a place where the traffic is very heavy

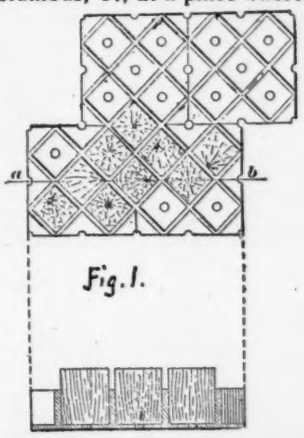


Fig. 1.

Fig. 2.

—a crossing over the sidewalk from the principal business street into the freight yards of the "Big Four Line," which has attracted considerable attention. It is a combination pavement of cast-iron pockets and bottom plate with oak blocks, making an even bottom surface and thus avoiding settling into holes. These iron pockets are filled with green oak blocks $3\frac{7}{16}$ in. square on the top and about 5 in. long. These blocks are driven into the iron pockets some 3 in., and receive the traffic on the end of the grain of the wood. Each full-sized bottom plate has 5 pockets, 4 half pockets and 4 quarter pockets. See detail drawings, figs. 1 and 2. Thus at the joints of the bottom plates in some instances, 2, 3, or even 4 bottom plates may support one of the hard-wood blocks, dividing the strain and holding an even surface on the upper side of pavement. Each iron pocket has a small hole for draining away any moisture. This surface stands the wear evenly, and the kind of traffic using it is heavy loaded wagons.

This block pavement was put down May 30, 1890, with the newly sawed oak blocks projecting 2 in. In August, 1890, I inspected it, and found them hammered and worn to $1\frac{7}{8}$ in. projection; and in September, 1891, another inspection showed them projecting about $1\frac{1}{4}$ in. above the metal pockets. The traffic crossing it includes largely loads of roofing slate and of rough curb-stones, in addition to the general commercial traffic of the "Big Four Line," and loads of from 3 to 5 tons each are quite frequent. The railroad yard surface is broken-rock macadam. The street is asphalt. I am informed that at this crossing new road metal has been deposited in the yard within 90 days, while the asphalt was renewed for some space from this block pavement about four months ago.

It appears that this pavement so far meets the requirements of

1. A substantial roadway to stand heavy traffic.
2. A good firm foothold for the horse.
3. A practically noiseless roadway suited to heavy traffic, but also comfortable for pleasure driving or a wheelman.

ELECTRICAL TRANSMISSION OF POWER.

(Abstract of paper by A. Saunders Morris; from the *Proceedings* of the Engineers' Club of Philadelphia.)

IF the calculations based by Herr Beringer on experiments made of the efficiency of hydraulic, pneumatic and wire-rope transmissions of power be accepted and compared with experiments on electric transmission, we find that power in large units can be transmitted by electricity more economically than by any of the other methods named for distances of 2½ miles or over. Wire rope is the only system which leads it for shorter distances. These electrical efficiencies are based on 90 per cent. efficiency of generator and motor respectively and a varying efficiency of line. The proper efficiency of the line, or, in other words, the energy lost between the generator and the motor, will depend upon the cost of the power, and interest and depreciation on the capital outlay. If the production of power is expensive it will, of course, be better economy to put more material in the line and lose less energy in the transmission. If we assume that 100 H.P. is available at the generator pulley, and that the efficiency of the generator and motor is 90 per cent. each, the horse-power delivered by the motor shaft will be 64.8 if the line efficiency is 80 per cent., and 72.9 if the line efficiency is 90 per cent. In the former case we will lose 18 H.P. in heating the copper line wire, while in the latter case but half that amount. The amount of copper in the line will be doubled in the latter case, but the cost of construction will be about the same. If we assume the cost of the motor to be proportional to the horse power, it will be increased about 10 per cent. We must therefore balance the additional cost of the line and motor against the value of the 10 per cent. additional power obtained at the motor pulley.

A few figures on the cost of transmission plants erected abroad by the Oerlikon Works may be of interest.

Distance in Miles.	Horse-Power Delivered.	Generators.	Motors.	Line.	Total.*	Per H. P. Delivered.
1 87	85	$3,135	$2,741	2,155	$9,220	$108.50
0.56	71	2,155	1,960	294	5,100	71.60
1.56	150	3,720	3,525	1,615	10,020	67.20
6.25	11	647	540	2,350	4,700	42.60
2.20	51	1,761	1,567	1,469	5,595	109.40
5.00	41	1,174	980	1,682	5,000	121.10
3.75	220	5,190	4,700	3,135	14,500	66.20
0.43	510	.....	.....	.....	33,250	65.30

The last plant on the list is at Schaffhausen, and consists of two generators of 300 H.P. each, one twin motor of 390 H.P., and two small motors of 60 H.P. each. The line consists of four stranded conductors having an area of .437 sq. in. each, and is supported at four points, exclusive of the termini. The manufacturers have guaranteed a commercial efficiency at ordinary full load of 78 per cent.; also that the machines must be capable of transmitting an excess of 20 per cent. over the normal power for one hour and a half without damage. The wear of one set of

* This includes regulating apparatus, poles, insulators, lightning arresters, erection and supervision.

brushes to be not less than 2,000 hours, and the life of a commutator not less than 2,000 hours. The variation of speed of the motors between running idle and under full load not to exceed 3 per cent.

In all of the previously mentioned plants direct or continuous current has been employed, but the difficulty of commutating currents of high potential has prevented the installation of many plants where the distances were so great that low potentials and heavy currents were financially impossible. This has led engineers to turn to the alternating current, not only on account of the ease with which it can be transformed from large quantity and low potential to small quantity and high potential and inversely, but also on account of the absence of commutators on either motor or generator. In avoiding the difficulties of commutation, engineers have been confronted by another —namely, the absence of an efficient alternating motor which would start itself. Any alternating current dynamo will run as a motor if it is brought up to speed in the first place; and further, unless very much overloaded, will maintain the same speed as the generator as absolutely as if it were mechanically coupled.

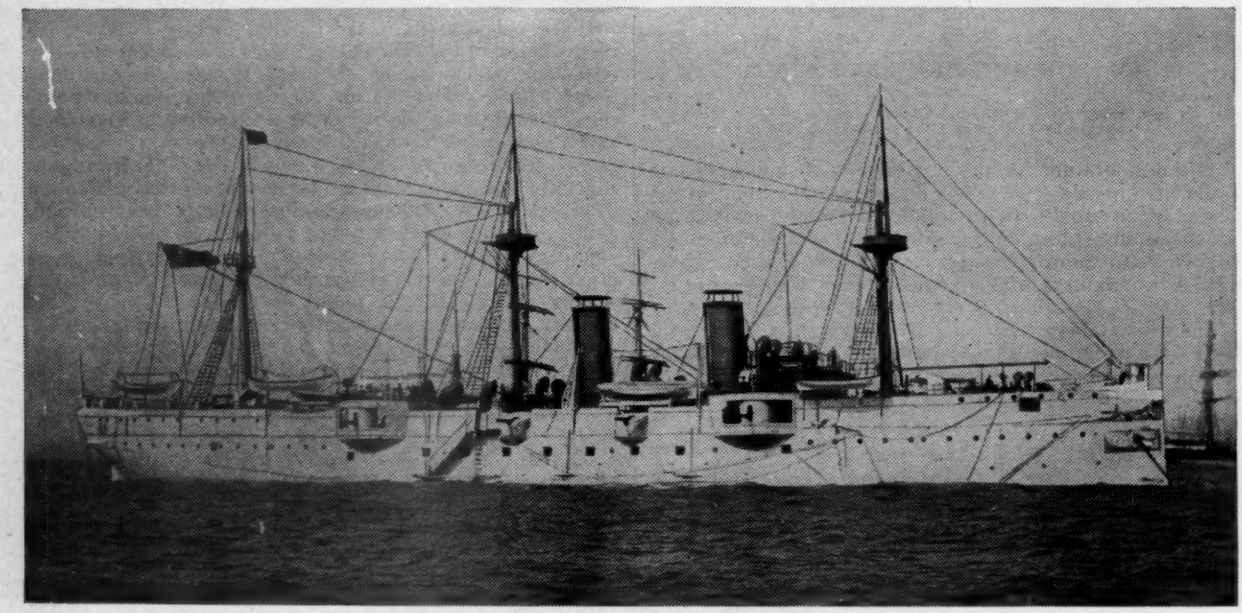
Another system of alternating current transmission has been devised, which overcomes the starting difficulty by the use of two or more currents differing in phase. This requires two or more wires, which are, however, in many cases unobjectionable. This is the type of generator and motor built by the Oerlikon Engineering Works for the Lauffen-Frankfort transmission plant.

In this country the number of transmission plants is comparatively small, and reliable information as to cost and efficiency is very difficult to obtain.

The Brush Electric Company has installed at the Dalmatia Mine in California a compound-wound generator, giving 40 amperes and 1,800 volts, which is driven by a Pelton water-wheel under a head of about 100 ft. The current is carried to the motor at the mine, 1½ miles distant, the power being used for driving stamps and other mining machinery.

In 1889 this company installed quite a novel plant at Virginia City, Nev. The water-power available at the level of the stamp mill was entirely inadequate to drive all the machinery, consisting of some 60 stamps with their complement of agitators, etc. It was then proposed, after using the water on the upper level, that it should be carried down a distance of 1,680 ft. to a chamber excavated in the Chollar Mine and utilized for driving electric generators, the current being carried back to motors located in the mill. The generators are six in number, each generator being driven by a Pelton water-wheel. They are compound-wound to give a constant current of 40 amperes. The wheels are 40 in. in diameter and are rated at 130 H.P. The commercial efficiency of this plant is said to be 70 per cent., and the horse power delivered is about 500. The installation is remarkable on account of the many difficulties which were encountered, such, for instance, as the moist atmosphere of the generator-room, being 78 per cent. saturation.

Another plant which is being installed by the same company is at the Calumet & Hecla mines. This plant consists of compound-wound generators, five in number, each capable of furnishing a current of 80 amperes at 970 volts, which is carried partly by an overhead line and partly by armored cable dropped through a bore-hole, a distance of about 8,000 ft., to the motors, also five in number, which drive the pumps. The speed of the generator is 850 and of the motors 920 revolutions per minute. The horse power delivered by each motor is something over 80, and the efficiencies of the generators, motors and line being each about 90 per cent., we have a commercial efficiency of almost 73 per cent. This plant is to be run in competition with a pneumatic system.



CRUISER "SAN FRANCISCO," UNITED STATES NAVY.

Probably the only long-distance transmission plant in this country in which alternating current is used was installed almost a year ago by the Westinghouse Electric & Manufacturing Company at Telluride, Col. The generator is capable of delivering about 30 amperes and 3,000 volts. The line is No. 3 B. & S. insulated wire, carried up the mountain on poles to the mine, a distance of 2.75 miles. This is a synchronous system—that is, as explained before, the motor and generator, being similar machines, run at exactly the same speed, irrespective of the amount of work done. The motor must therefore be brought up to speed by some auxiliary device before the current is thrown on. In this case the starting device is a small two-phase motor. Its efficiency is not important, as it has only to run for about three minutes, when the current is switched from it to the synchronous motor, and the load thrown on. There are some very simple devices for automatically breaking the circuit, if the motor should drop out of step from excessive load; and as there is no commutator to look after, or regulation to be done, the plant requires very little attention. The cost of this plant, exclusive of erection and pole line, is said to have been $10,000, or about $100 per H.P., and its commercial efficiency about 75 per cent.

The best electromotive force to be used must, to a certain extent, be decided for each case, the decision being governed by surrounding conditions, such as cost of power, distance of transmission, and the like.

LIMITATIONS OF ELECTRIC TRANSMISSION.

In planning an electric power transmission plant, care must be taken to select a type of motor best suited to the work to be done. The motor having the best starting torque is the direct current series-wound motor, but its speed will vary inversely as the load. If a direct current motor and constant speed is required, the compound-wound is the best; if alternating current is preferred, the synchronous motor is the best to use. Where low starting torque is not objectionable, the single-phase may be used; for high starting torque the synchronous multiple-phase may be used to good advantage. This must be considered only as a very general statement of the problem.

The allowable expenditures for copper conductor will largely determine the electro-motive force which may be used, and the general efficiency of the plant required will determine the line loss. This, as well as other conditions, will largely determine whether direct or alternating current is advisable. The practical limit of electro-motive force on direct current is reached at about 1,000 volts, for beyond this point the commutator begins to be troublesome.

With alternating currents, however, the voltage may be carried to 5,000 volts, and even higher if raising and lowering convertors are used, so that the potential on moving machinery may be kept down to a moderate figure. Alternating current motors do not in general require a commutator subjected to the high voltage used on the line, but, instead, have two or more solid rings or collectors, by which means sparking is entirely avoided.

The efficiency of direct and alternating current motors and generators is about the same, and may be taken at 90 per cent. as an average figure. The efficiency of the line will vary in practice from 75 to 95 per cent., which will give a plant efficiency, reckoned from the generator pulley to the motor pulley, of 61 to 77 per cent. One of the advantages of electrical transmission is that the plant efficiency remains almost constant for wide variations of load, for, as the motor and generator efficiencies decrease, the line efficiency increases.

An alternating current plant in Colorado, described above, ran for five months, six days in the week, and 24 hours a day, making a total of almost 3,000 hours, with interruptions due to trouble in the transmission plant aggregating only 30 hours, or about 1 per cent. One-half of this delay was for inspection of the line and building a crane to lift out the armature. The electro-motive force at the motor is 3,000 volts, and, according to last accounts, the plant was giving excellent satisfaction.

The design of a power transmission plant should involve consideration of (1) general nature of work to be done; (2) value of power at delivery and cost at generating station; (3) interest depreciations, etc., of plant; (4) losses in transmission; (5) voltage allowable. It will be seen from this that the problem is a very complex one, involving several variables, which are largely dependent on each other.

THE CRUISER "SAN FRANCISCO."

THE accompanying illustration is taken from a photograph of the cruiser *San Francisco*, of the United States Navy, which is one of the first of the large cruisers built for the new Navy. The building of the *San Francisco* was authorized by Congress in 1887, and the contract was let in July of that year to the Union Iron Works, in San Francisco. The ship was launched in October, 1889, and was finally completed in the summer of 1890.

The general dimensions of this ship are: Length over all, 328 ft.; length on water-line, 310 ft.; breadth, 49 ft. 6 in.; depth, 31 ft. 8 in.; mean draft, 18 ft. 9 in.; displacement with normal load, 4,083 tons. She is unarmored, with a heavy protective deck just above the water-line, and the machinery is further protected against injury by the arrangement of the coal bunkers. She has a double bottom through about 128 ft. of her whole length, and is divided into several watertight compartments.

The armament consists of twelve 6-in. breech-loading, rifled guns, all on center-pivot mounts, and protected by 2-in. segmental steel shields. Two of these guns are on the forward deck, two aft, and the rest in broadside, the broadside guns being mounted in sponsons; the arrangement is such that a heavy broadside fire can be brought to bear within a short distance of the ship. The secondary battery includes four 47-mm. revolving cannon, four 57-mm., and two 37-mm. rapid-fire guns and one Gatling gun. The ship is also provided with six torpedo tubes.

The *San Francisco* has twin screws, each screw being driven by a triple-expansion engine, having cylinders 42 in., 60 in., and 94 in. in diameter, and 42 in. stroke. The screws are three-bladed and 14 ft. 6 in. in diameter. The boilers, which are 15 ft. in diameter, are built for a working pressure of 135 lbs. The coal bunkers have a capacity of 850 tons.

On her trial trip the *San Francisco* made over 40 miles at an average of 19.66 knots an hour, and her engines developed 9,913 H.P., with 125 revolutions and a steam pressure of 135 lbs.

Since going into commission, the service of the *San Francisco* has been entirely on the Pacific. She has been on several cruises in that ocean, and was for some time in Chilian waters. At latest accounts, she was reported at Honolulu. She has proved herself a good sea boat, a fast sailer in time of need, although, of course, most of the cruising was done at slow speed. This ship is of the same class as the *Philadelphia*, and does not differ very much in size from the *Newark* and the *Charleston*.

PROGRESS IN FLYING MACHINES.

BY O. CHANUTE, C.E.

(*Continued from page 176.*)

IN 1886 and 1887 some experiments were tried at the Royal Dock Yards in Copenhagen, for the purpose of determining the relative efficiencies of screws operating in water, and those which should operate in the air. The experiments were in connection with marine, and not with aerial navigation; but it was found that not only would the aerial propeller develop as great a thrust as the water propeller, in proportion to the energy consumed, but that under certain conditions it would do slightly more, and greater thrusts per horse power were attained than in any previous experiments.

These very important results, for which most of our readers will be unprepared, warrant noticing the experiments at some length. They were described in a paper by *H. C. Vogt*, read before the British Association in 1888, and the first seems to have consisted in the careful measurement by Mr. *Freninges*, of Copenhagen, of the thrust and work done by a largish flying screw, two-bladed, 1 ft. in diameter and 1 ft. pitch, weighing 0.35 lbs. With 70 revolutions per second, it will rise 200 ft. into the air, and Mr. *Freninges* determined the efficacy or work done to be 63 per cent. of the kinetic energy imparted by the arm of the operator. At 52 revolutions per second, requiring the expenditure of 100 foot-pounds, the thrust of the screw against a stop was 6 lbs., and its efficiency therefore was $\frac{6 \times 550}{100} = 33$ lbs. per horse power, which agrees well with the measurements of Mr. *Wenham* and others.

The first dock-yard experiments were undertaken by Messrs. *Dahlstrom & Lohman*, and consisted in fitting out a launch 20 ft. long and 5½ ft. beam with an aerial screw propeller of canvas 8½ ft. in diameter, having 24 sq. ft. of area distributed over two ordinary canvas sails, the pitch of which could be varied. The engine was 1½ horse power. Measured by a spring balance, the thrust of the air propeller was, in calm weather, 36.7 lbs. per indicated horse power, or the same as that of a water-screw turned by the same power. In windy weather this thrust was augmented through 75 per cent of the directions in which the wind could blow, thus illustrating the fact that if a current of air be blowing across the blades the efficiency of a propeller will be increased, because many more particles of air will be acted upon in the same space of time than in a calm. This fact promises important consequences for an aerial screw in propelling, should a true flying machine ever be compassed, for then the ad-

vancing screw would constantly have fresh particles of air to work upon, and there would be a reduction in the slip which necessarily must occur when its thrust is measured in a fixed position.

The next experiment was tried with the Government Dock Yard launch, which was 31 ft. long and 8 ft. beam. Its ordinary water screw was removed, and an air propeller of canvas was substituted, which was 20 ft. in diameter and had a total area of 250 sq. ft. This area was found much too large, but by reducing it to about 150 sq. ft. an average speed of nearly 7 knots was attained by the launch, whose speed with the ordinary water screw and the same power (11.3 indicated horse power) was a maximum of 7.3 knots per hour. There was, however, a slip of the driving rope which was estimated as wasting about 2 horse power, and the director estimated that the speed with the air propeller would have been 7.5 knots per hour if the gear had worked properly. As on previous trials, 75 per cent. of the winds increased the thrust of the propeller.

The apparatus for the next experiment, which was tried in 1887, was made by Messrs. *Dahlstrom & Lohman*, engineers, of Copenhagen. An air propeller with three vanes of thin sheet steel, and an area of about 5 sq. ft., was fitted to a boat 16 ft. long and 4½ ft. beam, and rotated by man power. It is stated to have produced a thrust of 10 lbs., with an effort of about 100 foot-pounds, or at the astonishing rate of 55 lbs. per horse power; but it must have been assisted by wind blowing athwart the blades, for Mr. *H. C. Vogt*, in a letter published in London *Engineering* for December 4, 1891, says, in discussing Aerodynamics, that "with 1 indicated horse power it is not possible to obtain a thrust of over 40 lbs. to 45 lbs. with an air propeller—say 50 lbs. to 60 lbs. per brake horse power on the shaft—just the same in whatever manner area, pitch, and revolutions are varied."

On the basis of these Copenhagen experiments Mr. *John P. Holland*, in a very interesting letter, published in the New York *Herald* in November, 1890, claims that it is even now possible to navigate the air upon the screw principle, by simply combining things already tried and proved by various experimenters; and he gives the elements of a proposed steam apparatus, weighing some 7,000 lbs., and capable of carrying two men, with supplies of fuel, etc., sufficient to sail from 8.44 to 23.6 hours. Details of the design and method of operation are withheld until a patent can be secured. As has already been said in referring to Mr. *Maxim*, it is probable that such a machine can be made to rise upon the air; but special appliances will be required to secure safety in case the machinery breaks down while under way, and in effecting a landing.

A somewhat similar proposal is made in a pamphlet published in 1891 by Mr. *James Means*, of Boston, but he gives only a scanty glimpse of the arrangement by which he thinks the problem could be solved. He proposes one screw on a vertical shaft, sustaining a car with a pair of widely extended vertical planes, to prevent rotation of the apparatus, and concludes by saying: "If you want to bore through the air, the best way is to set up your borer and bore."

Our knowledge of the action of aerial screws is almost wholly experimental; and it would seem, in the present chaotic state of theory as applied to the screw, as if this remark of Mr. *Means* was almost as comprehensive and reliable as anything on the subject of aerial screws which has been published up to the present time. The writer feels quite certain that it contains in a condensed form as much reliable detailed solid information as several mathematical articles of considerable complexity which he has consulted, and it will be seen, by closely analyzing Mr. *Means's* suggestion, that after its entire adoption in the spirit in which it is made, there would be little left to be desired in the development of aerial screws.

Among the inventors who have most deeply and most intelligently studied the action of screws must be mentioned M. *G. Trouvé*, of Paris, whose artificial flapping bird has already been noticed under the head of "Wings." He has proceeded almost wholly in the experimental way, and he has accomplished some very remarkable results. He began his experiments with marine screws applied to electric launches about 1881, and soon developed an electric motor weighing but 33 lbs. per horse power (primary battery not included), which rotated an improved marine screw some 2,400 turns per minute.*

In 1886 he exhibited to the French Academy of Sciences a new method of constructing geometrically accurate screws by a process so simple that any workman can carry it out, and that the cost is very much reduced. He has also experimented, ever since 1867, with aerial screws, and has reached the conclusion that for the latter the best results are obtained when the pitch is equal to the diameter, or a little less,† contrary to marine practice, where pitch is generally 1.3 times the diameter.

In 1887, at the Scientific Congress at Toulouse, and in 1888, before the French Société de Physique, M. *Trouvé* exhibited the electric motor and aerial screw represented in fig. 35. The motor is the lightest ever built, weighing but 3.17 oz., and developing 868 foot-pounds per minute, or at the astonishing rate of 1 horse power for each 7.42

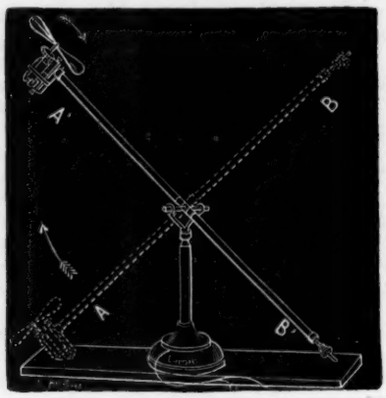


FIG 35.—TROUVE—1886.

lbs. weight. It is wholly of aluminum, except the magnetic circuit, which is necessarily of very soft iron; and the armature is directly connected with a very light aerial screw, geometrically perfect, which was constructed by the process communicated to the French Academy of Sciences.

This apparatus, upon being placed in one pan of a pair of scales, and connected with a source of electricity of 40 Watts constant delivery, lightened itself of its entire weight by action upon the air. To make the experiment more striking, M. *Trouvé* then arranged it at the extremity of a balanced beam, as shown in the figure, connecting it with the electric supply through the standard, the knife edges and the beam. Then upon turning on the current, the screw began to revolve, and the balanced beam rose from the position *A B* into the position *A' B'*, with the expenditure of 868 foot-pounds per minute, which M. *Trouvé* says is capable of raising it at the rate of 72 ft. per second.

Inasmuch as he estimates that this minute motor has only an efficiency of 20 per cent., and that a similar one of 50 to 100 horse power would possess an efficiency of 80 to 92 per cent., it would seem that M. *Trouvé* now has it in his power to go up into the air with a pair of aerial screws, rotating in contrary directions in order to insure stability, moved by his wonderfully light motor, to float, to hover, and to move about at pleasure so long as he remains within the limits of length, of strength and of weight of a connecting wire to convey the electric force from a dynamo and steam engine, which remain on the ground, to the electric motor and aerial screw in the air.

This, as he points out, would be of practical use on the battle-field or in a besieged city, to observe the enemy; and it is not impossible that he will exhibit such an apparatus at some International Exposition; but he believes that he has now designed a still better solution of the problem; and we shall see, when we come to treat of aeroplanes, that he made the plans for an apparatus of that kind which seems to him to solve, both in arrangement

* Histoire d'un Inventeur—Barral. Page 416. † *Ibid* Page 442.

and motive power, the all-important question of the navigation of the air.

For several years past series of experiments upon aerial screws, both for sustaining and for propelling, have been carried on by *Commandant Renard*, at the French Aeronautical War Establishment at Chalais. He published a preliminary paper in the *Revue de L'Aéronautique*, in 1889, in which he gave a description of the machine used in testing, and of the results of the experiments with the screw of the war balloon *La France*, which is two bladed, nearly 23 ft. in diameter, with an average pitch of 27.5 ft. and a surface of about 42 sq. ft.

He found that the efficacy of this screw, or its thrust in pounds divided by the foot-pounds exerted, varied from 48.4 lbs. per horse power at 17 turns per minute, down to 16.94 lbs. per horse power, with 48 turns per minute; and he calls attention to the fact that inasmuch as the thrust increases as the square of the velocity, while the power required grows as the cube, the proper method of comparing the efficiencies of various forms of screws is to compare the quotients obtained by dividing the cubes of the thrusts by the squares of the powers.

Commandant Renard seems to have so proceeded in comparing his experiments; and in a paper read by him before the French Society of Physics, in 1889, he stated that of seven forms of screws tried up to that time, one was much better than the others; and he added from theoretical considerations: "There must be a screw for which $\frac{\text{Thrust}^3}{\text{Power}^2}$ = constant, is a maximum. This is confirmed by experiment; and it shows, moreover, that this maximum when plotted resembles a sharp peak, each side of which forms a *veritable precipice*. In other words, there is a screw very much better than others, and its form cannot be much departed from without producing very bad aerial screws."

None of the forms of screws experimented upon are published, save that of *La France*, and that this is not the best may be inferred from the fact that Mr. *Maxim*, who tested about fifty different forms of screws in his recent experiments, says: "The screw which gave the worst results was made exactly like those employed in the experiments of the French Government."

Mr. *Maxim* has published a popular account, all too brief, of his experiments, in the *Century Magazine* for October, 1891, but for obvious reasons does not go into scientific details. He has expressed the intention of eventually doing so, and this is sure to prove a very great addition to our present scanty knowledge, for his experiments on aerial screws have been more systematic and comprehensive than any heretofore tried.

From the foregoing it will be seen that comparatively few experiments have been made to compass artificial flight by means of sustaining aerial screws, and that much, very much remains to be learned concerning the best form to be given to them, the proper area, velocity and pitch, as well as the power required, either for sustaining or for propelling a given weight in the air with a screw. Indeed, even for marine screws, our knowledge may be said to be wholly empirical—that is to say, based on experiment; and there is no mathematical theory of them which has found general acceptance, or which connects their action with that of plane surfaces, so as to agree with the observed facts. Some calculations made by the present writer seem to indicate that it may be less difficult to do so, in the case of aerial screws; but it must be acknowledged that we really know but little about them, and that the most that we can say at present is that while a flying machine in which the sustaining power is to be obtained from rotating screws is likely to require less surface than an aeroplane to sustain the same weight, perhaps in the proportion of about one-third, yet it is likely to require more power than the aeroplane to obtain the same speed of translation, and also to involve greater risks of accidents in case of failure of any part of the machinery.

It would seem to the writer as if the true function of aerial screws was to propel, leaving the sustaining power to be obtained in some other way, and we will therefore pass to the consideration of AEROPLANES.

(TO BE CONTINUED.)

UNIFORM STANDARD TIME.

AT the January convention of the American Society of Civil Engineers the Committee on Uniform Standard Time —Messrs. Sandford Fleming, Charles Paine, Theodore N. Ely, T. M. Toucey and T. Egleston—presented an interesting report, from which we take the following extract:

At the annual meeting in January, 1891, the Committee reported that railroad men continued to be heard from, and that up to date a total number of 403 presidents, managers and others in the highest official positions (nearly all of whom had communicated directly with the Society) had expressed themselves in favor of the adoption of the 24-hour notation. As the aggregate length of railroad with which these officers are connected is about 140,000 miles, it appears obvious that the proposal to adopt the 24-hour notation meets with general assent, that there is no insuperable obstacle in the way of its introduction throughout North America, and that the change may be effected at any time by joint arrangement among railroad men.

The Committee reported the adoption of the 24-hour notation throughout the Indian Empire and on the short railroad mileage in China. Within the year 1890 the mileage of railroad on which the new notation had been permanently introduced had increased from less than 4,000 miles to over 20,000 miles. The Committee reported on the progress of the time reform movement in Europe, and referred to the official correspondence issued by the British Government to all the British colonies around the globe, recommending the principles of Standard Time and the new notation of the hours, which this Society has long advocated.

The Committee has now to report that during the past year the advance of the movement has been most marked in Europe. For a number of years back the question has been under discussion among scientists, in the press, and from time to time in some of the legislatures of European nations. The most remarkable speech recorded is that of the late Count von Moltke in the Imperial German Parliament at the sitting of March 16. This, perhaps the last public utterance of the illustrious and aged statesman-soldier, from the influence it has had in Europe and will continue to have throughout the world in extending the advantages of a movement in which this Society has taken a leading part, must be of interest to every member.

By the latest information from Europe it appears that the Belgian Minister of Railroads, Posts and Telegraphs has issued a notice to all the services connected with the departments, announcing that from May 1, 1892, Standard Time will be used. He invites all the railroad companies to adopt the same reckoning, and asks his colleagues in the Government to issue directions, for all services, to conform to the new reckoning in their relations with the public. The Government of Holland has likewise taken decisive action, and authorized the adoption of Standard Time based, as in Belgium, on the zone of the Greenwich meridian. This decision will come into force on May 1, 1892, for the interior service, in Dutch territory. From April next, Standard Time, based on the reckoning of the meridian 15° east, will be introduced in the States of Bavaria, Wurtemburg, Baden, and Alsace-Lorraine. Since October 1, 1891, Austria Hungary has, by official authority, adopted Standard Time in all its public services. In Prussia there has been much discussion and much difficulty, owing to a reactionary movement, but a change followed the wise views expressed in the Reichstag by the late Field-Marshal von Moltke, and now it is by Imperial direction that the adoption of Standard Time is proposed. It is not unlikely, therefore, that the proposition will be finally resolved upon at the next sitting of the Chambers.

The strange opposition of France to the general introduction of Standard Time shows signs of weakening. It is true that France still isolates herself in this matter, as she did at the Washington conference, from all the other nations who voted for the meridian passing through Greenwich as the prime meridian to be common to all. But France has made some approach to uniformity by adopting the reckoning of Paris as the time for the whole nation.

The reckoning of Paris differs from Standard Time only nine minutes, and it cannot be doubted that the good sense of the French people must eventually lead them to join their neighbors in a common system of uniformity by sacrificing the small difference of nine minutes to general expediency.

From the latest information received, it is evident that Europe is now making the first great step in time reform which America made in 1883, in introducing Standard Time into general use. In the second important step, the adoption of the 24-hour notation, this country is somewhat anticipated by India, and we need not be greatly astonished to hear of a rapid development of the reform in Europe, when once the first step is fully taken. Already in the Belgian Parliament a prominent member, M. Houzeau de Lehaie, has moved the Government to introduce the 24-hour notation.

It cannot but be a matter of congratulation to the American Society of Civil Engineers that this important movement for placing time reckoning on a proper scientific basis makes progress in so many quarters. It is recognized that this Society has been one of the first and most active prime movers, that it has greatly stimulated the movement, not in this country alone, but throughout the globe; and it cannot be doubted that the Society must eventually receive the fullest credit for the action which it has taken from the beginning.

THREE-RAIL TURNOUTS FOR DOUBLE-GAUGE TRACKS.

By James K. Geddes, C.E.

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(*Continued from page* 185.)

TURNOUTS FROM CURVES.

In discussing turnouts from curves, we will consider the subject, for brevity's sake, as turnouts from the inside of the curve, and turnouts from the outside of the curve, without going into all the details as to the arrangement of the rails. From the foregoing discussion for turnouts from tangents, the engineer may readily determine the similar cases for curves.

Let us first take up the subject of turnouts from the inside of a curve. Two cases will be considered.

CASE I.

We will first consider the case where the main track curve is to the right, with the turnout curve likewise to the right, with the third rail on right of center, as shown in fig. 11.

LENGTH OF THROW-RAILS.

The length of the throw-rails may be determined as follows: In fig. 10 let $H\ P$ represent the center line of main track and $H\ N$ the center line of turnout curve, R the radius of main track, R' the radius of turnout curve, and assume $P\ N$ as the throw $= \frac{1}{2}\ d$. Then in the triangle $C\ B\ N$ we have the side $C\ N = R - \frac{1}{2}\ d$, $C\ B = R - R'$ and $B\ N = R'$. Let $s =$

$$\frac{R' + (R - R') + (R - \frac{1}{2}\ d)}{2}.$$

Then, by trigonometry, we have

$$Sin.\ \tfrac{1}{2}\ C\ B\ N = \sqrt{\frac{(s - R')\ (s - (R - R')}{R' \times (R - R')}}$$

and the angle

$$N\ B\ M = \frac{180^\circ - C\ B\ N}{2}.$$

Then in the right-angled triangle $N\ B\ M$ we have the three angles and the side $N\ B = R'$ given to find the side $N\ M = \frac{1}{2}\ N\ H$, and from trigonometry,

$$N\ M = Sin.\ N\ B\ M \times R'. \qquad (12)$$

Example:

Given radius main track, $R = 573.7$, the radius of turnout track $R' = 380$, and the throw 5 in. $= .417$ ft., to find the length of chord of throw-rail $N\ H$:

$$s = \frac{380 + (573.7 - 380) + (573.7 - 0.417)}{2} = 573.491$$

$s - R = 573.491 - 380 = 193\ 491$	2.2866607
$s - (R - R') = 573.491 - 193.7 = 379.791$	2.5795446
$R = 380.000$ ar. comp.	7.4202164
$R - R' = 193.700$ ar. comp.....	7.7128704
Extracting sq. root.....	2)19.9992921
$\frac{1}{2}\ C\ B\ N = 87^\circ\ 41'$.....*sin.*	9.9996460

from which the angle $C\ B\ N = 175^\circ\ 22'$ and the angle

$$N\ B\ M = \frac{180^\circ - 175^\circ\ 22'}{2} = 2^\circ\ 19'.$$

Then,

$2^\circ\ 19'$.....	*sin.* 8.6066226
$R = 380$.....	2.5797836
$N\ M\ 15.36' = 15'\ 4\frac{1}{2}''$.	1.1864062

from which $N\ H = 30'\ 8\frac{1}{2}''$.

The length of the arc $H\ N$ may be found in the same manner as described for Eq. 7.

To find the frog angle $D\ A\ E = B\ A\ C$, fig. 11, of the first frog, given the radius of main track $= R$, the radius of the turnout $= R'$ and the standard gauge $= g$.

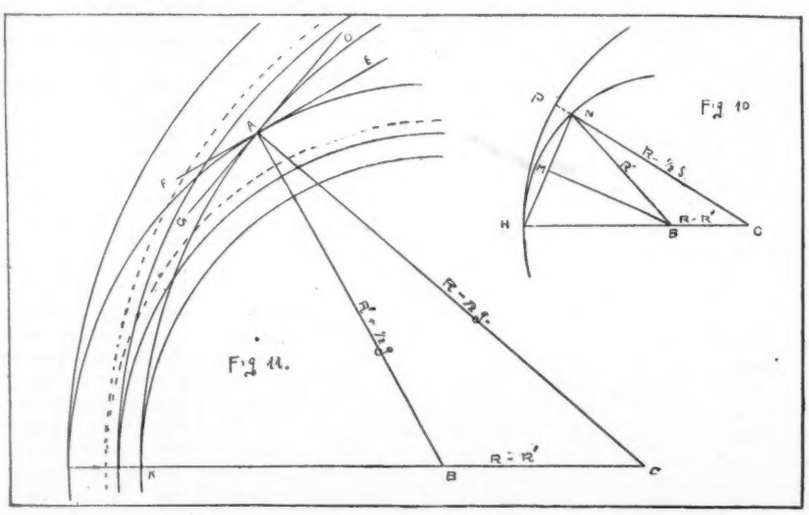
In the triangle $B\ A\ C$ we have given the side $A\ C = R - \frac{1}{2}\ g$, $A\ B = R' + \frac{1}{2}\ g$ and $B\ C = R - R'$.

$$\text{Let } s = \frac{(R - R') + (R - \tfrac{1}{2}\ g) + (R' + \tfrac{1}{2}\ g)}{2},$$

then, from trigonometry, we have

$$Sin.\ \tfrac{1}{2}\ B\ A\ C = \sqrt{\frac{[s - (R - \frac{1}{2}\ g)]\ [s - (R' + \frac{1}{2}\ g)]}{(R - \frac{1}{2}\ g)\ (R' + \frac{1}{2}\ g)}}. \qquad (13)$$

It will be noted that in this case the result is not affected by the width of the narrow gauge g'.



Example: Given the radius of the main track, $R = 573.69$, the radius of the turnout $R' = 380\ 00$, and the standard gauge $= 4$ ft. $8\frac{1}{2}$ in. $= 4.708$ to find the frog angle $D\ A\ E = B\ A\ C$, fig. 11:

$s = (573.69 - 380) + (573.69 - 2.354) + (380 + 2.354) = 573.69$

$s - (R - \frac{1}{2}\ g) = 2.354$.....	0.3718065
$s - (R' + \frac{1}{2}\ g) = 191.336$	2.2817967
$R - \frac{1}{2}\ g = 571.336$ ar. comp....	7.2431084
$R' + \frac{1}{2}\ g = 382.354$ ar. comp....	7.4175343
Extracting sq root.....	2)17.3142459
$\frac{1}{2}\ B\ A\ C = 2^\circ\ 36'\ 9''$.....*sin.*	8.6571229

whence the angle $B\,A\,C$ is 5° 12′ 18″—the required answer.

To find the frog angle $D\,A\,E = B\,A\,C$, fig. 12, of the second frog, given the radius of the main track $= R$, the radius of the turnout $= R'$, the standard gauge $= g$, and the narrow gauge $= g'$.

In the triangle $A\,B\,C$ we have the side $A\,C = R + \frac{1}{2}g - g'$, the side $A\,B = R + \frac{1}{2}g$, and the side $B\,C = R - R'$.

$$\text{Let } s = \frac{(R - R') + (R + \frac{1}{2}g - g') + (R' + \frac{1}{2}g)}{2},$$

then, from trigonometry, we have

$$Sin.\ \tfrac{1}{2}\,B\,A\,C = \sqrt{\frac{[s-(R+\frac{1}{2}g-g')]\ [s-(R'+\frac{1}{2}g)]}{(R+\frac{1}{2}g-g)\ (R'+\frac{1}{2}g)}} \quad (14)$$

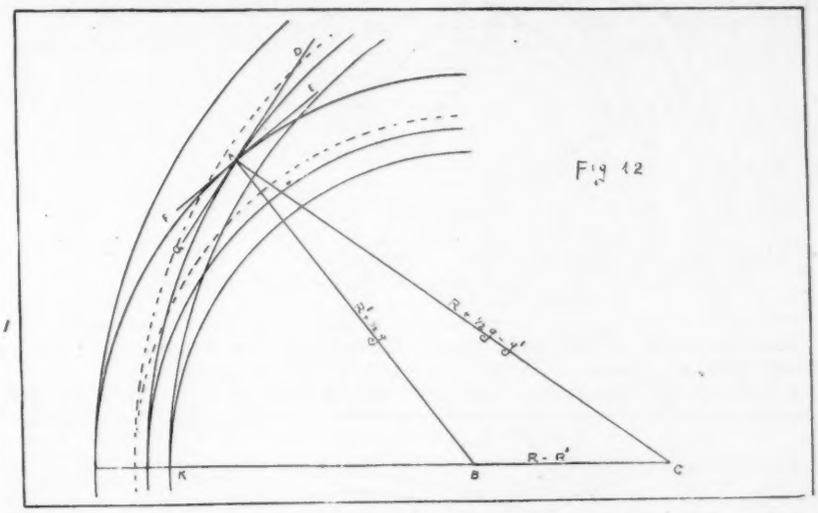
metre = 3.281 ft.—to find the frog angle $D\,A\,E = B\,A\,C$, fig. 12 :

$$s = \frac{(573.69-380)+(573.69+2.625-3.281)+(380+2.625)}{2} = 574.674$$

$s - (R + \frac{1}{2}g - g') = 1.640$.....	0.2148438
$s - (R' + \frac{1}{2}g) = 192.049$.....	2.2834120
$R + \frac{1}{2}g - g' = 573.034$ ar. comp.	7.2418196
$R + \frac{1}{2}g = 382.625$ ar. comp.....	7.4172267
Extracting sq. root.....	2)17.1573021
$\frac{1}{2}\,B\,A\,C = 2°\ 10'\ 19''$.....*sin.*	8.5786510

whence the angle $B\,A\,C$ is 4° 20′ 38″—the answer required.

To find the frog angle $D\,A\,E = B\,A\,C$, fig. 13, of the third or double-pointed frog, given the radius of the main track $= R$, the radius of the tournout $= R'$, the standard gauge $= g$, and the narrow gauge $= g'$.



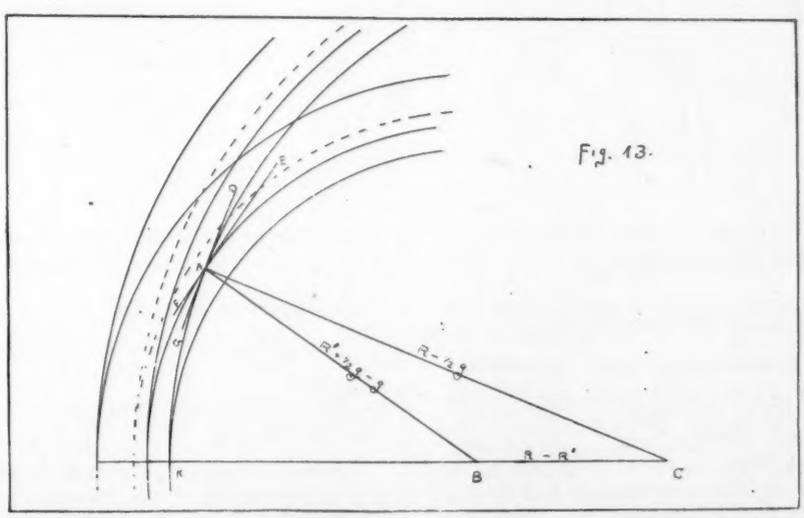
Example No. 1 : Given the radius of the main track $R = 573.69$, the radius of the turnout $R' = 380$, the standard gauge $g = 4$ ft. 8½ in. $= 4.708$, the narrow gauge $g' =$ 3 ft. 0 in.—to find the frog angle $D\,A\,E = B\,A\,C$, fig. 12 :

$$s = \frac{(573.69-380)+(573.69+2.354-3.000)+(380+2.354)}{2} = 574.544$$

Here in the triangle $A\,B\,C$ we have the side $A\,C = R - \frac{1}{2}g$, the side $A\,B = R + \frac{1}{2}g - g'$, and the side $B\,C = R - R'$.

As before, let $s =$ the $\frac{1}{2}$ sum of the three sides, or

$$s = \frac{(R - R') + (R - \frac{1}{2}g) + (R' + \frac{1}{2}g - g')}{2}$$



$s - (R + \frac{1}{2}g - g') = 1.500$....	0.1760913
$s - (R' + \frac{1}{2}g) = 192.190$.....	2.2837308
$R + \frac{1}{2}g - g' = 573.044$ ar. comp.	7.2418121
$R' + \frac{1}{2}g = 382.354$ ar. comp.....	7.4175343
Extracting sq. root.....	2)17.1191685
$\frac{1}{2}\,B\,A\,C = 2°\ 4'\ 44''$.....*sin.*	8.5595842

whence the angle $B\,A\,C$ is $= 4°\ 9'\ 28''$.

Example No. 2 : Given the radius of the main track $R = 573.69$, the radius of the turnout $R' = 380$, the standard gauge $g = 5$ ft. 3 in. and the narrow gauge $g' = 1$

and we have

$$Sin.\ \tfrac{1}{2}\,B\,A\,C = \sqrt{\frac{[s-(R-\frac{1}{2}g)]\ [s-(R'+\frac{1}{2}g-g')]}{(R+\frac{1}{2}g-g')\ (R-\frac{1}{2}g)}} \quad (15)$$

Example No. 1 : Given the radius of the main track $R = 573.69$ ft., the radius of the turnout $R' = 380$, the standard gauge $g = 4$ ft. 8½ in. $= 4.708$, and the narrow gauge $g' = 3$ ft. 0 in., to find the frog angle $D\,A\,E = B\,A\,C$, fig. 13 :

$$s = \frac{(573.69-380)+(573.69-2.354)+(380+2.354-3.00)}{2} = 572.190$$

$s - (R - \frac{1}{2}g) = 0.854$.....	1.9314579
$s - (R' + \frac{1}{2}g - g') = 192.836$....	2.2851881
$R' + \frac{1}{2}g - g' = 379.354$ ar. comp.	7.4209553
$R - \frac{1}{2}g = 571.336$ ar. comp.....	7.2431084
Extracting sq. root.....	2)16.8807097
$\frac{1}{2}\,B\,A\,C = 1°\ 34'\ 46''$. .....*sin.*	8.4403548

whence the angle $B\,A\,C = 3°\ 09'\ 32''$.

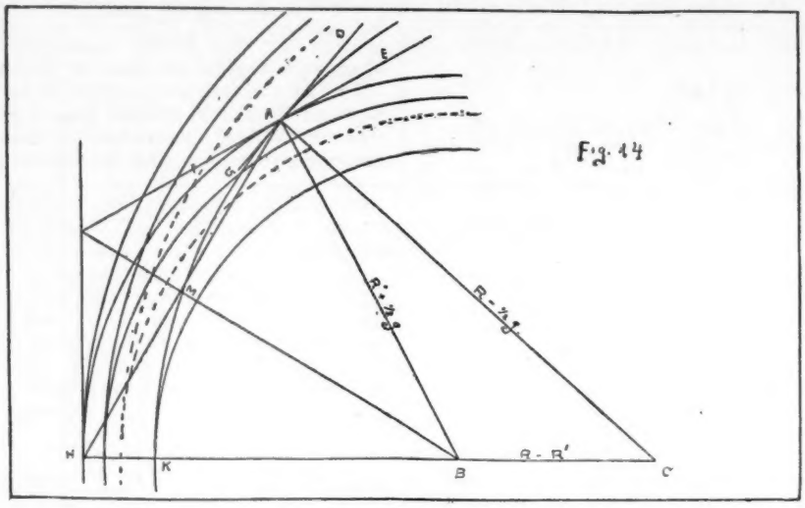


Fig. 14

Example No. 2: Given the radius of the main track $R = 573.69$, the radius of the turnout curve, $R' = 380$, the standard gauge $g = 5$ ft. 6 in., and the narrow gauge $g' = 3$ ft. 6 in., to find the frog angle $D\,A\,E = B\,A\,C$, fig. 13:

$$s = \frac{(573.69 - 380) + (573.69 - 2.75) + (380 + 2.75 - 3.5)}{2} = 571.94$$

$s - (R - \frac{1}{2}g) = 1.00$.....	0.0000000
$s - (R' + \frac{1}{2}g - g') = 192.69$....	2.2848592
$R' + \frac{1}{2}g - g' = 379.25$ ar. comp..	7.4210744
$R - \frac{1}{2}g = 570.94$ ar. comp.....	7.2434095
Extracting sq. root.....	2)16.9493431
$\frac{1}{2}\,B\,A\,C = 1°\ 42'\ 34''$. .....*sin.*	8.4746715

whence the angle sought is $3°\ 25'\ 8''$.

CASE II.

Under this case will be considered the case where the curve of the main track is to the right, the turnout to the right, with the third rail on the left of the center.

To find the frog angle $D\,A\,E = B\,A\,C$, fig. 14, of the first frog, given the radius of the main track $= R$, the radius of the turnout $= R'$, and the standard gauge $= g$.

In the triangle $B\,A\,C$ we have given the side $A\,C = R - \frac{1}{2}g$, $A\,B = R' + \frac{1}{2}g$, and $B\,C = R - R'$. Thus it will be seen that the sides of the triangle are the same as in the case for fig. *M*, where the third rail is on the right of the center, and hence the angles must be equal. Therefore, the angle required is found from equation 13—viz.:

$$Sin.\ \tfrac{1}{2}\,B\,A\,C = \sqrt{\frac{[s - (R - \frac{1}{2}g)]\ [s - (R' + \frac{1}{2}g)]}{(R - \frac{1}{2}g)\ (R' + \frac{1}{2}g)}}.$$

To find the frog angle $D\,A\,E = B\,A\,C$, fig. 15, of the second frog, given the radius of the main track $= R$,

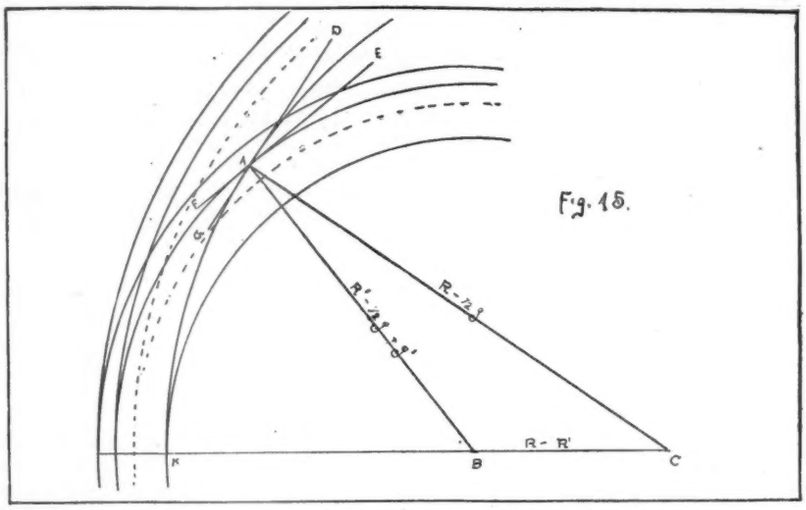


Fig. 15.

the radius of the turnout $= R'$, the standard gauge $= g$, and the narrow gauge $= g'$.

In the triangle $B\,A\,C$ there are given the side $A\,C = R - \frac{1}{2}g$, the side $A\,B = R' - \frac{1}{2}g + g'$, and the side $B\,C = R - R'$.

As in previous cases, let

$$s = \frac{(R - \frac{1}{2}g) + (R' - \frac{1}{2}g + g') + (R - R')}{2}.$$

Then will

$$Sin.\ \tfrac{1}{2}\,B\,A\,C = \sqrt{\frac{[s - (R - \frac{1}{2}g)]\ [s - (R' - \frac{1}{2}g + g')]}{(R - \frac{1}{2}g)\ (R' - \frac{1}{2}g + g')}} \quad (16)$$

Example: Given the radius of the main track $R = 573.69$, the radius of the turnout $R' = 380$, the standard gauge $g = 4$ ft. $8\frac{1}{2}$ in. $= 4.708$, and the narrow gauge $g' = 3$ ft. 0 in., to find the frog angle $D\,A\,E = B\,A\,C$, fig. 15:

$$s = \frac{(573.69 - 2.354) + (380 - 2.354 + 3.00) + (573.69 - 380)}{2} = 572.836$$

$s - (R - \frac{1}{2}g) = 1.5$....	0 1760913
$s - (R' - \frac{1}{2}g + g') = 192.190$..	2.2837308
$R - \frac{1}{2}g = 571.336$ ar. comp.....	7.2431084
$R' - \frac{1}{2}g + g' = 380.646$ ar. comp.	7.4194788
Extracting sq. root.....	2)17.1224093
$\frac{1}{2}\,B\,A\,C = 2°\ 5'\ 11''$.....*sin.*	8.5612046

whence the angle sought is $4°\ 10'\ 22''$.

By comparing this result with that obtained in Example No. 1, Eq. 14, it is found that the same number of frog will answer for either of these cases.

To find the frog angle $D\,A\,E = B\,A\,C$, fig. 16, of the third or double-pointed frog, given the radius of the main track $= R$, the radius of the turnout $= R'$, the standard gauge $= g$, and the narrow gauge $= g'$.

In the triangle $B\,A\,C$ there are given the side $A\,C = R - \frac{1}{2}g + g'$, the side $A\,B = R' + \frac{1}{2}g$ and the side $B\,C = R - R'$.

As before, let

$$s = \frac{(R - \frac{1}{2}g + g') + (R' + \frac{1}{2}g) + (R - R')}{2}.$$

Then will

$$Sin.\ \tfrac{1}{2}B\,A\,C = \sqrt{\frac{[s-(R-\frac{1}{2}g+g')]\ [s-(R'+\frac{1}{2}g)]}{(R-\frac{1}{2}g+g')\ (R'+\frac{1}{2}g)}}. \quad (17)$$

Example: Given the radius of the main track $R = 573.69$, the radius of the turnout $R' = 380$, the standard gauge $g = 4$ ft. $8\frac{1}{2}$ in $= 4.708$, and the narrow gauge $g' = 3$ ft. 0 in., to find the frog angle $D\,A\,E = B\,A\,C$, fig. 16:

$$s = \frac{(573.69-2.354+3.00)+(380+2.354)+(573.69-380)}{2} = 575.190$$

$s - (R - \frac{1}{2}g + g') = 0.854$.....	1.9314579
$s - (R' + \frac{1}{2}g) = 192.836$.....	2.2851881
$R - \frac{1}{2}g + g' = 574.336$ ar. comp.	7.2408339
$R' + \frac{1}{2}g = 382.354$ ar. comp.....	7.4175343
Extracting sq. root.....	2)16.8750142
$\frac{1}{2}\,B\,A\,C = 1°\ 34'\ 9''$.....*sin.*	8.4375071

Therefore $B\,A\,C = 3°\ 08'\ 18''$.

It is not deemed necessary here to discuss the other cases of turnouts from the inside of curves, where the turnouts are trailing switches, as distinguished from the facing switches discussed, nor turnouts from the inside of a curve where the main track curve is to the left, with the facing and trailing switch.

From what has already been said concerning these cases where the turnouts are from tangents, it will be readily seen that the frog angles remain the same, the only difference in the frogs being in the manner of curving them.

To find the radius of the turnout curve from the inside of the curve, given the radius of the main track $= R$, the gauge $= g$, and the frog angle $D\,A\,E = B\,A\,C$, fig. 14:

In the triangle $A\,C\,H$,

$HC+AC : HC-AC :: \text{tang. } \frac{1}{2}HAC+AHC : \text{tang. } \frac{1}{2}HAC-AHC$

now, $HC = R + \frac{1}{2}g$

and $AC = R - \frac{1}{2}g$.

Hence $HC + AC = 2R$ and $HC - AC = g$.

The angle $HAC = HAB + BAC$ while

$HAC + AHC = 180° - HCA$ and

$HAC - AHC = BAC$.

Substituting these values in the above proportion, we have

$$2R : g :: \text{tang. } \tfrac{1}{2}(180° - HCA) : \text{tang. } \tfrac{1}{2}BAC.$$

But the tang. $\frac{1}{2}(180° - HCA) = $ tang. $90° - \frac{1}{2}HCA$, and from the proportion we have the equation

$$\text{tang. } 90° - \tfrac{1}{2}HCA = \frac{2R \times \text{tang. } \frac{1}{2}BAC}{g}.$$

But since the tangent of 90° minus a given angle is equal to the cotangent of the given angle, we have, from the above, the equation

$$\text{cot. } \tfrac{1}{2}HCA = \frac{2R \times \text{tang. } \frac{1}{2}BAC}{g}. \quad (18)$$

This analysis (as well as that for Eq. 27) is somewhat analogous to that employed by Henck in the case where a switch angle is used, instead of regarding the whole turnout as being the arc of a circle.

Example: For finding the central angle:

Given the radius of the main track $R = 573\ 69$, the frog angle $D\,A\,E = B\,A\,C = 5°\ 12'\ 18''$, the gauge $g = 4$ ft. $8\frac{1}{2}$ in. $= 4.708$, to find the central angle $HCA = BCA$, fig. 14:

$2R = 1147.38$.....	3.0597073
$\frac{1}{2}BAC = 2°\ 36'\ 09''$.....tang.	8.6575669
$g = 4.708$ ar. comp.....	9 3271635
$\frac{1}{2}HCA = 5°\ 9'\ 30''$.....cot.	1.0444377

whence the angle required, $HCA = BCA = 10°\ 19'\ 00''$.

Having thus found the angle HCA, the remaining one $CBA = 180° - (BAC + ACB)$.

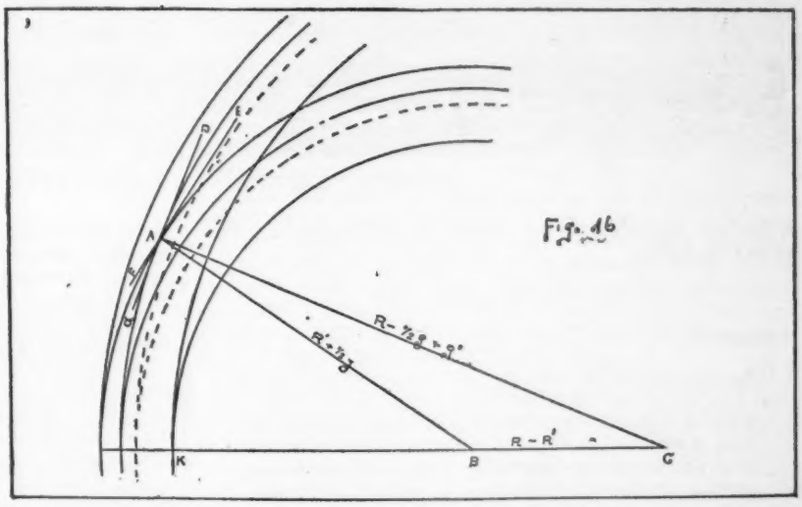
It now remains to find the side AB in the triangle ABC, fig. 14. Here there are given the three angles and one side, $AC = R - \frac{1}{2}g$, to find $AB = R' + \frac{1}{2}g$.

$$R' + \tfrac{1}{2}g = \frac{R - \frac{1}{2}g \times Sin.\ BCA}{Sin.\ CBA}. \quad (19)$$

Example: Given the radius of the main track $R = 573.69$, the frog angle $D\,A\,E = B\,A\,C = 5°\ 12'\ 18''$, the gauge $g = 4$ ft. $8\frac{1}{2}$ in. $= 4.708$, to find the radius R' of the turnout curve, fig. 14.

Having found from Equation 18 the angle $BCA = 10°\ 19'\ 00''$, and then the angle $CBA = 164°\ 28'\ 02''$, we proceed as follows:

$R - \frac{1}{2}g = 571.336$.....	2.7568916
$BCA = 10°\ 19'\ 00''$.....*sin.*	9.2530675



$CBA = 164°\ 28'\ 42''$ ar. comp..*sin.*	0.5725094
$R' + \frac{1}{2}g = 382.356$.....	2.5824685

Subtracting from this result the value of the $\frac{1}{2}$ gauge $= 2.354$, we have as the radius of the turnout 380 002.

THE CHORD DISTANCE.

Having thus found the radius of the turnout curve, the chord distance HA, fig. 14, may be readily found.

The angle $HBA = 180° - CBA$, the angle $MBA = \frac{1}{2}HBA$, and $BAM = 180° - (BAM + MBA)$. Thus in the right-angled triangle ABM we have the three angles and the side $AB = R' + \frac{1}{2}g$ given to find the $\frac{1}{2}$ chord distance AM.

From trigonometry,

$$AM = (R' + \tfrac{1}{2}g) \times Sin.\ MBA. \quad (20)$$

Example: Given the radius of the main track $R = 573.69$, the radius of the main track $R' = 380$, and the gauge $g = 4$ ft. $8\frac{1}{2}$ in. $= 4.708$, to find the chord distance HA.

The angle $HBA = 180° - 164°\ 28'\ 42'' = 15°\ 31'\ 18''$ and $MBA = \frac{15°\ 31'\ 18''}{2} = 7°\ 45'\ 39''$.

$R + \frac{1}{2}g = 382.354$	2.5824657
$M B A = 7° 45' 39''$ ..... *sin.*	9 1304568
$A M = 51.633$	1.7129225

whence $H A = 103.266$.

To find the length of arc $H A$ from the heel of the switch to point of frog, fig. 14:

If it be desired to find the length of the arc measured along the outer rail of the turnout curve from the heel of the switch to point of frog, we may proceed in a manner analogous to that employed for Eq. 8.

Thus, in fig. 14 represent the central angle $H B A$ by b, the radius $B A = R + \frac{1}{2}g$ by r; then will the whole arc of which r is the radius be equal to $2 r \pi$, and the part of the arc included by the central angle b must be given by the equation

$$\text{Arc } H A = 2 r \pi \frac{b}{360°}.$$

Example:

Let $b = 15° 31' 18''$
$r = 382.354'$

$2 (R + \frac{1}{2}g) = r = 764.708$	2 8834957
$\pi = 3.1416$	0.4971499
$b = 15° 31' 18'' = 55878''$	4 7472409
$360° = 1296000''$ ar. comp	3.8873950
Arc. $H A = 103.581$	2.0152815

In a similar manner to the above may be found the arc along this outer rail from the heel of the switch to point of the frog for any other case where the turnout is from the inside of the curve.

(TO BE CONCLUDED.)

THE UNITED STATES NAVY.

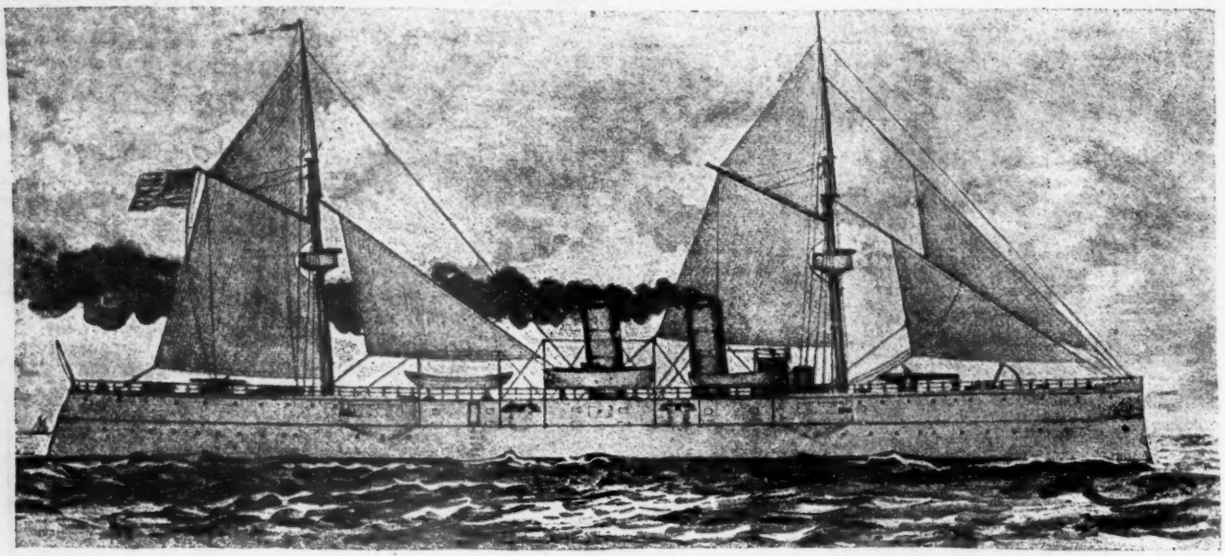
THE next new ship to be launched will be the practice cruiser for the Naval Academy, which the S. L. Moore & Sons Company is building in its yard at Elizabeth, N. J. It was expected that this vessel would be launched about April 30.

IT is stated that the Navy Department is preparing plans for a new armored cruiser resembling the *New York*, but with some modifications from that ship. It is probable that Congress will authorize the building of a vessel of this class at anyrate, even if no other new ships are put in the Naval Appropriation Bill.

LAUNCH OF THE "RALEIGH."

THE new cruiser *Raleigh* was successfully launched at the Norfolk Navy-Yard, March 31, with appropriate ceremonies, a number of officers and invited guests being present. The *Raleigh* is one of the 3,000-ton cruisers, the building of which was authorized in 1888. The other ship of this class, the *Cincinnati*, is now under construction at the New-York Navy-Yard, where also the engines for both ships are being built. The accompanying view of this ship is taken from the Report of the Bureau of Construction of the Navy Department.

The *Raleigh* is an unarmored steel cruiser, the only protection consisting of a protective deck, of the arrangement of the coal bunkers, and of coffer-dams filled with cellulose surrounding the engines and magazines. The general dimensions are: Length, 300 ft.; extreme breadth, 42 ft.; mean draft, 18 ft.; displacement, 3,180 tons.



CRUISER "RALEIGH," UNITED STATES NAVY.

She has twin screws, each driven by a triple-expansion engine with high-pressure cylinders 36 in.; intermediate, 53 in., and two low-pressure cylinders, each 57 in. in diameter, all being 33-in. stroke. These engines are expected to work up to 10,000 H.P. with forced draft, and to give the ship a speed of 20 knots. There are four main boilers, double-ended, and two auxiliary boilers, single-ended.

The main battery will include one 6-in. breech-loading rifle, mounted on the forecastle, and ten 5-in. rapid-fire guns, two mounted on the poop and the others on the gun deck. All of these guns will be protected by steel shields. The secondary battery will consist of eight 6-pounder rapid-fire guns, and of two Gatling guns mounted in the tops. There will also be six torpedo-tubes arranged for Howell torpedoes.

The ship will carry a full electric light plant, consisting of two engines and dynamos, and will be provided with three search-lights.

The engine power of these ships is high in proportion to their size, and they are expected to be fast ships and very useful cruisers.

THE CELLULOSE TRIALS.

THE Board which had charge of the trials of cellulose as a protection for ships has made a preliminary report, and it is understood that the results have been satisfactory enough to warrant the Navy Department in ordering the adoption of this material for the three battle-ships—the cruisers *New York* and Nos. 12 and 13.

The contracts for these vessels call for the use of either cellulose or woodite, as may be determined by the Department. Cellulose will be the material used, though on account of its tendency to become foul when damp, the

coffer-dams built inside of the steel hulls back of the armor protection will not be filled with the material until there is danger of hostilities. The cellulose will be kept on hand in convenient form to be placed in a vessel whenever needed. In the plans for these vessels provision is made for this buoyancy protection material. As a result of its experience in connection with the experiments, the Board submits the following conclusions and recommendations:

1. The cellulose used in coffer-dams for obturating purposes should be packed loose, and great care taken to obtain the required specific gravity, when packed, of 0.12.

2. In packing the coffer-dams, compression should be obtained by means of jacks or other appliances, by which the pressure is applied gradually and evenly. The cellulose should never be rammed or treated in a manner calculated to pulverize it.

3. A thorough and uniform mixing of granular and fibrous cellulose is essential if the best results are to be obtained. To receive this it would seem desirable that the cellulose be mixed at the manufacturer's works and supplied at the ship-yards ready for use.

4. In order to insure durability of the material, the coffer-dam compartment must be made watertight. The Board recommends that they be tested in the most thorough and rigid manner by repeatedly filling with water under a moderate pressure until found to be absolutely watertight, being afterward thoroughly painted inside and out.

5. Although not absolutely essential, it is believed that the most satisfactory results will be obtained when the top of the coffer-dam is made removable, or in cases where this is impracticable, where there is a manhole in every frame space. Under these circumstances it is possible to obtain the requisite compression of the cellulose with much greater certainty than when one manhole must be used for filling the length of several frame spaces of the coffer-dams.

SEA-COAST BATTERIES.

By Lieutenant Joseph M. Califf, Third U. S. Artillery.

(*Continued from page 160.*)

THE DISAPPEARING GUN-CARRIAGE.

That guns can no longer be fought without cover and in the open is fully conceded by engineer and artilleryman alike. In the United States, to secure the needed protection for our guns, they propose to give us the disappearing gun-carriage—that is, a mount that shall retain the gun below the parapet during the process of loading, and only bring it into view while it is being pointed and fired.

The exact character of the mount has not yet been fully decided upon, but in general terms it may be said that two distinct types are proposed—one the disappearing carriage proper, the other the gun lift. The former, without going into details, can be described as suspending the gun from the extremities of two strong metal arms in its proper relation to the parapet over which it is to fire; that when fired it is thrown out of equilibrium by the force of recoil, and under the action of this force and its own weight it sinks below the parapet. At the same time, the energy developed by the recoil is, by means of proper appliances, stored up in the form of compressed air, a compressed metal spring, or, as in the case of the counterpoise carriage, of a raised counter-weight. When the force of recoil is exhausted and the gun is in a proper position for loading, it is caught automatically and there held. By opening a valve, releasing the spring, or by bringing the counter-weight into action, the gun is raised to its original position for firing. With the gun lift, the gun, and its carriage are raised vertically for firing from its position below the parapet by hydraulic or other machinery, and lowered by the same means after it has been discharged. The lift is proposed for all guns of over 10-in. caliber.

It will be seen that while the gun is in its firing position it is wholly without protection, and that even when below the parapet the protection secured both for the gun and the men who serve it is more apparent than real. When the disappearing carriage was first invented, muzzle-loading guns were in use, and in their service the ammunition supply and almost the entire gun detachment were under cover. With breech-loading guns of great length the cannoneers must perform their duties from 30 to 50 ft. back from the parapet, and without overhead protection of any kind; so that, except for security against direct fire, the personnel of a battery are no better off than they were thirty years ago.

Let us see how the conditions of attack and defense have changed during this time, it being taken for granted that the improvement in heavy guns for ship and for shore batteries has been about equal.

For the attack (1) the introduction of machine and quick-firing guns in large numbers on board of war-ships of every class, and the consequent enormous increase in the possible volume of fire; (2) increased facilities for obtaining ranges, and (3) increased power of shell.

It is difficult to appreciate the extent to which machine and quick-firing guns have come into use on board the modern war-ship. On board the new English battleships we shall find, in addition to the four 67-ton guns of the main battery, secondary and auxilliary batteries of ten 6-in. and 24 other quick-firing guns. The *New York*, when finished, will have, besides her six 8-in. rifles, 24 quick-firing guns from 1-pdrs. to 4-in., and 4 machine guns; and so on through the navy list of every civilized power.

The amount of metal that can be thrown by guns of this character in a limited space of time will be understood when we remember that the 6-in. Armstrong (100-pdr) has been fired on board ship, changing aim after each shot, ten shots in a little more than two minutes; that the 4 7-in. Armstrong (45-pdr.) and the corresponding caliber Canet gun can fire six aimed or twice as many unaimed shots per minute; that Krupp's 27-pdr. can fire ten, and his 76-pdr. seven aimed shots in the same time; that the 37-mm. Hotchkiss can be fired 80 shots per minute, each projectile weighing 1 lb. and giving from 10 to 12 useful fragments, or about 800 fragments per minute, with a maximum range of about 5,000 yds.

Quick-firing howitzers must now be added to the weapons against which open batteries will in future have to contend. The Grüson (4.72-in.) 36-pdr. quick-firing howitzer can fire 10 shots per minute at an elevation of 35° and a range of 6,000 yds. The English are about adopting a quick-firing howitzer, and many of the large English war-ships now building are to have at least one of these guns at the bow, mounted for high-angle fire.

When we remember that all but the largest calibers of these quick-firing guns have mounts that admit of great elevation or of curved fire, and the great number of guns of this kind even a moderate sized fleet will carry and can bring to bear upon any particular point within a 6000-yard range, or greater, a very little calculation will show what a veritable rain of projectiles can be delivered—projectiles or fragments that may not be able to dismount a gun, but are amply sufficient, with their angle of fall, to search out the gunners behind the parapet and to disable the delicate attachments of a disappearing gun-carriage. As pertinent to the question of high-angle fire from ships, against which the open battery is practically defenseless, it is well to call attention to the fact that last year the English naval authorities made a successful experiment with a 9 2-in. high-power rifle mounted on the gunboat *Handy* upon a Vavasseur carriage of peculiar construction. Elevations from zero to 30° were employed without undue strain upon the ship's deck.

The Fiske and other range finders have been brought to such a degree of perfection that there should be little difficulty in locating the position of shore batteries, or in their absence, the lighter guns may be relied upon to determine the range. Besides, the captain of a ship in approaching any well-known harbor is not feeling his way over untrodden ground. On the contrary, a competent pilot, or, say, the master of any one of the scores of foreign ships that weekly come into the port of New York, is, one may say, familiar with every foot of ground from Scotland Lightship to his dock in Hoboken or Jersey City. With a properly prepared chart before him, with his lead on the

bottom and his ranges on shore his own position is a matter of certainty, as is that of any located point on shore, as of a battery or group of batteries; and he has this advantage, that while his adversary's position is fixed and always known, by keeping under way, his own is never the same from one moment to another.

It must be admitted by any one familiar with the effect of shrapnel that if a reliable time fuse were at hand, the power of the attack as against open batteries would be increased many fold. That we shall have such a fuse in the near future seems to be beyond a doubt. The Chief of Ordnance in his report for the present year announces that they have found a reliable combination time and percussion fuse and are experimenting with a mechanical time fuse. To obtain the maximum effect of shrapnel fire against gunners or material, a time fuse that will explode the projectile in the air above or in front of the objective point is necessary, but even percussion shell or shrapnel can do murderous work.

To meet these undisputed gains in the power of the attack, our military engineer proposes (1) the disappearing gun; (2) mine defense, and (3) mortar batteries. The disappearing gun-carriage has been called the fad of the day with the engineer and ordnance officer, and takes the lead; yet the Chief of Ordnance in his last reports laments that no satisfactory carriage of this description has as yet been devised. Of the various proposed types, the pneumatic carriage now on the proving ground at Sandy Hook seems to be the most in favor. This is described as being of such complicated construction as to require an expert engineer to run it; and just now, owing to the breaking of a cog-wheel during some experimental firing, it is laid up for repairs.

The gravest objection to this class of gun-mounts is that, outside the fact that they do not afford the required protection to the personnel, they are all more or less complicated and easily disabled. To lift a hundred tons of metal, more or less, from behind a parapet surely and quickly, and then to swing or lower it back again behind its cover, bespeaks such strength of material, so perfect an adjustment of parts, such perfection of detail, that one can be pardoned for being thoroughly skeptical both as to its mechanical practicability as well as the wisdom of trusting so costly a product as a heavy high-power rifle to the keeping of a contrivance that even a bit of shell or a shrapnel bullet may put out of order. Captain Chester, in writing of the necessity of simplicity in all the appliances and methods to be employed in time of war, very truly says: "War is a rough business, and is conducted in a rough way by rough and often awkward men. Delicate instruments and flimsy fittings are out of place in it. There should be no chance for the gunner to disable his own gun, and as little chance as possible for the enemy to do it. If possible, there should be nothing about it that will break, as strength and simplicity are prime requisites in all warlike machines."

A summary of Lieutenant Fletcher's Report on European Naval Ordnance Material applies equally to that for land service:

> Present tendencies abroad indicate a speedy return to hand power for gun mountings, with a limited use of steam or electricity. Considered simply as machines, hydraulic mountings are perfect, but they are not fitted to the adverse conditions of sea service and actual war. . . . The life of the gun, as it were, hangs by a thread, which may be severed by a most trivial and unforeseen cause; and it is a question if the gun is not in as much danger of being disabled by the complicated character of its mountings as by the fire of the enemy.

If in a mount of the kind proposed a pump fails to work, a cog-wheel is broken, a truck gets out of gear, a lever or valve fails to perform its perfect function, your gun goes out of action as surely as if bowled over by a thousand-pound shot.

The extent to which submarine mines will modify the former conditions of attack and defense of seaports is hard to say. It is believed they have been given an exaggerated value. An attacking fleet, provided with all the modern appliances for countermining and clearing a channel, would be little handicapped provided the fire of the defense could be controlled or silenced, as it most surely would be if reliance is placed wholly or in large part upon open batteries of any kind.

In our present scheme of coast defense mortar batteries have been given a very prominent place. No one can deny the disastrous effect of a heavy mortar shell upon the deck of the strongest ironclad, and the wonderful accuracy obtained in practice firing with the rifled mortar is admitted. But when, instead of known distances, clear skies, and the utmost deliberation, we have a target enveloped in smoke, whose position and distance is largely a matter of guess, it is believed that the hitting of such an object will be purely a matter of chance; besides, if the position of such batteries are known—as there is no reason to doubt they will be—it will be within the power of the attack to make the efficient service of this class of guns, which must always be in open batteries, as hazardous if not as impossible as that of rifles upon disappearing mounts.

In considering a scheme of defense that takes such risks with its material alone, it must not be forgotten that in the modern plan of sea-coast armament we have not, as in the days of smooth-bore guns, fifty, a hundred, or perhaps several hundred guns in a single work, or to defend a single approach, when the loss of even a dozen guns was not a matter of vital import, but, on the contrary, a number that is relatively very small; nor that, almost without exception, the naval gun's crew is provided with cover that is at least proof against machine-gun fire and shell splinters.

In connection with this question of relative armament under the old and new conditions, it is interesting to recall what was considered necessary in *ante-bellum* days. In an elaborate report made in 1851, by General Totten, Chief Engineer of the Army, upon "A System of National Defense," we find that, including works already completed, under construction, and those planned for, an aggregate of 1,327 guns and mortars was provided for the defense of New York, of which about two-thirds were for the Southern approach. The allowance made by the Board of Fortifications in 1886 for the same purpose is 95 guns and 144 mortars. For the defense of Boston we find 763 guns and mortars deemed necessary against 43 guns and 132 mortars under the allotment of 1886. Under the same scheme Hampton Roads was to be provided with 538 and Fort Adams with 414 guns and mortars. According to General Totten's estimate, 12,685 guns were required for the Atlantic and Gulf Coasts, at an estimated additional cost for construction and armament of nearly $33,000,000. The estimate of 1886 for covering the same ground was for 1,012 guns and mortars, and an expenditure of about $76,000,000. It should be remembered that under the old system of casemate works all but absolute protection was provided for guns and gunners against the ordnance of the day for a very large percentage of the guns mounted.

The problem of sea-coast defense is a large one, the proper solution of which cannot be overestimated in importance. What has been said has been inspired by a belief in the real danger of committing ourselves so entirely to open batteries as we seem to be doing.

The line upon which this question should be solved is not difficult to discern. That we must construct at all points thoroughly shot-proof armored batteries is not claimed. It is claimed, however, that overhead cover, sufficiently strong to be proof against shell splinters and machine-gun projectiles, is absolutely necessary, if we expect to be able to fight our guns.

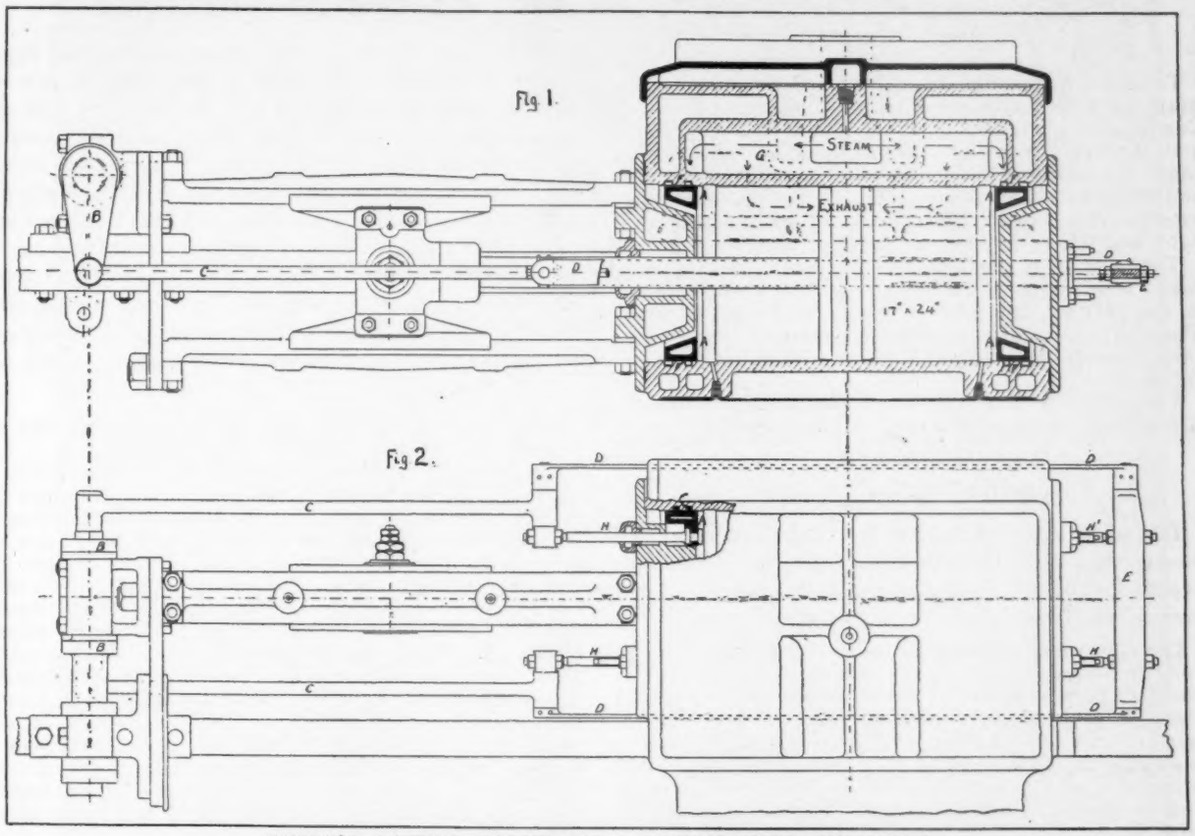
The English propose in one way to meet this question with what they call "open battery shields," in which the cover is a 2-in. steel plate properly supported by girders and covered with a layer of concrete and earth, or the batteries are so prepared that in case of need they can be quickly covered with timber or iron, or both.

At all important points and in exposed positions iron-protected batteries are believed to be those the modern conditions of war demand. If the question of greater cost is raised, it may be truthfully stated that a single gun perfectly protected will, in time of need, be of infinitely greater value than an open battery of many guns, and at the same time, considering the expensive character of the disappearing mount, will have the item of cost in its favor.

War is a trade in which one cannot with safety stop to question the cost of one's tools, although it must be admitted that this is a truth the average law-maker finds it hard to comprehend.

A NEW VALVE FOR LOCOMOTIVE CYLINDERS

IN the JOURNAL for January, 1889, pages 43 and 44, there was described a new form of valve for steam-engines devised and patented by Mr. F. D. Child, of West Newton, Mass.; the drawings given herewith show this valve as applied to a locomotive cylinder. Fig. 1 is a longitudinal section of the cylinder and cross-head; fig. 2, a plan; fig. 3, a cross-section through the center of the cylinder, and fig. 4, an end view showing the front head. The drawings show a 17 × 24-in. cylinder arranged to replace a cylinder and steam-chest of the ordinary pattern on a locomotive which has been already in service.



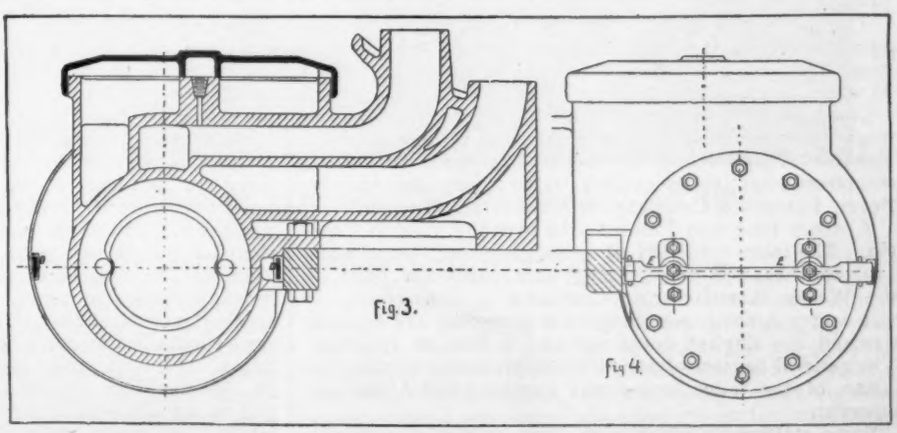
CHILD'S PISTON VALVE ON A LOCOMOTIVE CYLINDER.

The peculiar features of this arrangement, which is especially adapted for high speeds, are that the valves, which are of the piston type, are not in a separate steam chest, but in the cylinder itself. The ports run entirely around the cylinder and the valves are annular in form, consisting of a ring in each end of the cylinder. The method of working them is readily seen from the drawings; *A A* are the valves; *B* is the rocker-arm, and *C C* are the valve-rods; *F F* are the ports. The valve at the back end of the cylinder is worked directly from the valve-rods by the two valve-stems *H H*; that at the forward end is worked by the valve-stems *H' H'* from the cross-head *E*, which is connected to the valve-rods *C C* by the two flat connecting rods *D D*, one on each side of the cylinder. They may also be worked by having two rockers, one at each end of cylinder. There is a second bearing for the rocker, which is bolted to guide-yoke, as shown. In this case the engine has the form of guides and cross-head shown, but the arrangement can readily be adapted to double guides and a box cross-head.

The arrangement of the steam and exhaust-ports is shown in section in fig. 3.

While the valves shown are simply piston-valves of an annular form, the objects which the inventor has sought to accomplish by their position and arrangement are:

1. The valves are perfectly balanced.
2. They admit steam at once around the whole circumference of the cylinder.



3. The steam has a very short distance to travel—none, in fact, from the valve to the inside of the cylinder.
4. The steam is admitted and exhausted through separate ports, so that the steam-port is not cooled by the exhaust.

5. The travel of steam is always in the same direction in the ports.

6. There is no loss of steam in the ports at each stroke, the clearance in the cylinder ends being only a little more than usual; the amount depending on the closeness of construction and possibility of running.

7. The admission and exhaust-ports throughout are of great capacity.

The amount of work required to fit up this valve is not greater than that required for a cylinder with the ordinary slide-valve; it is less, in fact, if the absence of a steam-chest is considered. These valves may be fitted with packing, same as piston, if desired.

A SHOP CORNER.

THE accompanying illustration is from an excellent photograph of a corner in the shops of the Scarritt Furniture Company, in St. Louis. The chief point shown is a novel and ingenious overhead arrangement devised by Mr. John D. Elliott, the details of which can readily be seen and studied out from the engraving. The photograph, an excellent one of its kind, was taken by a magnesium flash light, and shows the shop corner very distinctly.

The overhead carriage and tightening arrangement keep the belt tight on the milling machine at all times and in any position, and when it is run along the lathe-bed. The milling machine carries end mills, spiral cutters, emery wheels, drill chucks, etc., and is thus a tool of universal use.

The picture is interesting as showing some practical details of shop economy in a very striking way.

ARGENTINE RAILROADS.

THE following extract from a letter recently received shows something of the railroad situation in the Argentine Republic. The writer, it may be said, is a resident of that country, and familiar with the situation:

The Government seems to be trying to force all the subsidized roads here into a corner of some kind. Just what they propose to do it is difficult to see—in fact, impossible. The situation is most difficult. The country is overrun with 5 ft. 6 in. gauge *English* railroads, costing as all English roads do to build. These roads are owned in England, coal is brought from England, and so are all other supplies. Dividends must be paid in England. Now this simply means that the roads must be run on a *gold* basis—and gold to-day is worth $3.42½ in paper for one gold dollar. The people here get paper and not gold for their labor, and the difficulty is a growing one. Much of the produce of the country can be valued on a gold basis because it has an export value.

The railroads here are governed to death; and a manager cannot do the simplest thing out of the ordinary routine without submitting it to some petty official, unless he wants to make his company liable to a fine.

Compound locomotives are all the rage here, as you might suppose with fuel scarce. The Buenos Ayres & Rosario Railroad has some very business-like-looking compounds hauling its express trains; they were built by Beyer, Peacock & Company, of Manchester, England.

A short time ago I took a trip over this road to Rosario. The train consisted of a baggage car, two (American) coaches, and five sleeping cars, the latter built by the Wason Manufacturing Company, at Springfield. It was a very American-looking train except for the locomotive and the English couplings and buffers on the cars. The general neglect of the minor appliances and the condition of the toilet rooms was anything but American, however.

Some statements which have been circulated as to discoveries of coal are to be received with caution. The truth is, that if the coal deposits are really valuable, they are a long way from any railroad, and even if accessible it could not compete with foreign coal in Buenos Ayres or anywhere on the seaboard, even if railroad rates were reduced one-half, owing to the long haul needed. It is not yet certain that the deposits are valuable enough to pay for working.

The Argentine Great Western Railroad, by the way, has 12 locomotives equipped to burn the crude petroleum from Mendoza.

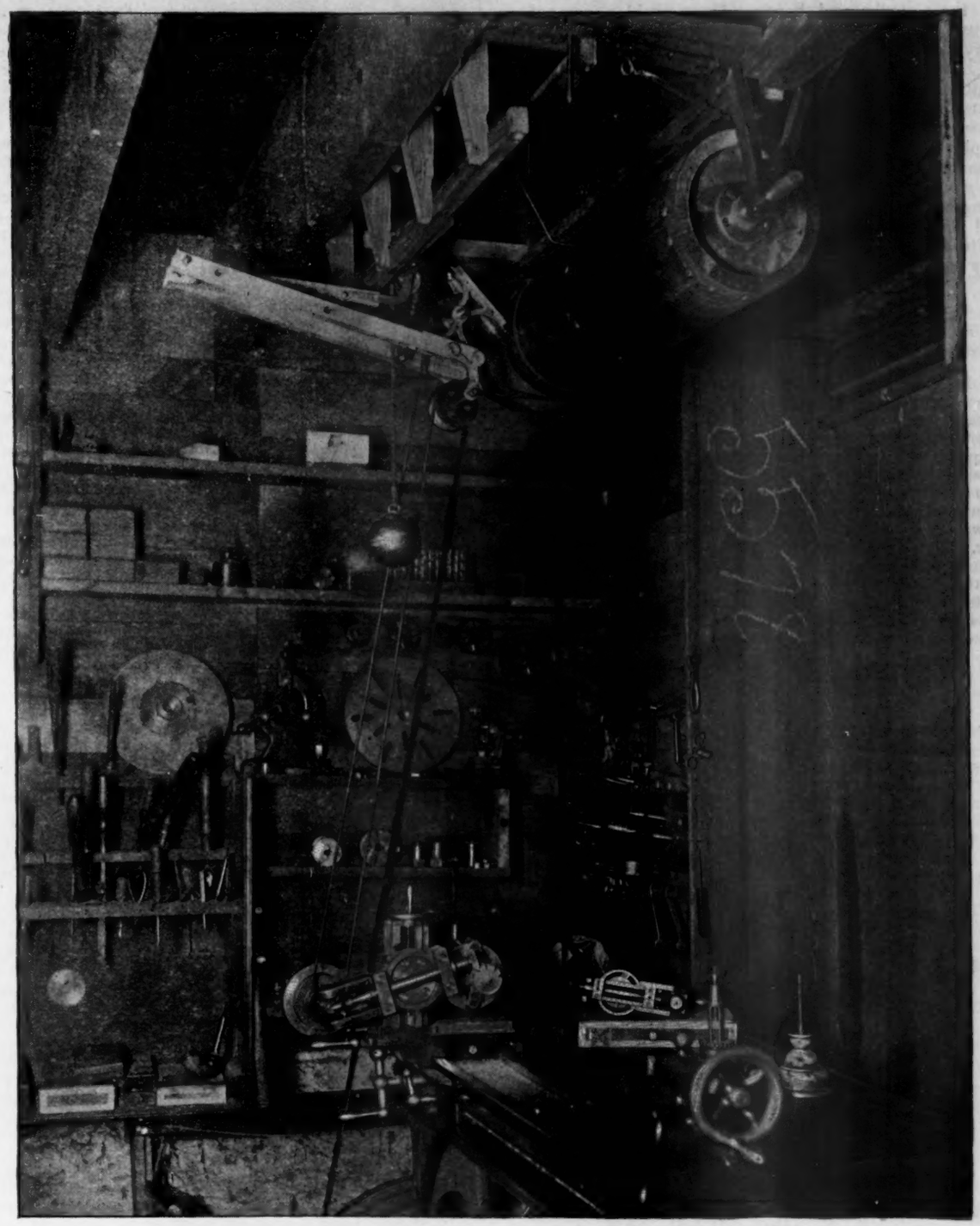
There is no doubt that some of the best men realize that the adoption of American methods would have been much better for the country. This was prevented, however, by the English capital which was put in in the first place, but some changes are now possible.

CAR COUPLER LEGISLATION.

AT the annual meeting of the American Railroad Association the President, Mr. H. S. Haines, made a very interesting address on this subject. He gave very fully the history of the action of the Master Car Builders' Association which led finally to the adoption of the present standard; the approval of this action by the American Railroad Association—formerly known as the General Time Convention—and spoke also of the progress made thus far in adopting the standard. The address also refers at some length to the bills which have been introduced in Congress to provide for the compulsory adoption of a safety coupler, and in conclusion gives reasons for opposing action on these bills as follows:

It has been said to us: "If you oppose the selection of a safety coupler by a plebiscite of railroad employés or by a congressional commission, what sort of compulsory legislation do you favor?" Our answer may be made in the language of the Massachusetts Railroad Commission: "Those who urged that there should be no legislation at all upon the subject claimed that the railroad companies were proceeding in the development and adoption of automatic couplers as rapidly as possible, and that any legislation would be likely to saddle upon the country some device, unsatisfactory and imperfect; would impose upon the railroad companies great expense with no corresponding benefit to the employés, and would, in fact, be a bar to progress toward perfection. This argument is of weight and should not be disregarded, unless the circumstances are of a nature so exceptional as to justify a departure from a principle of legislation which for many years has been generally adhered to in this State with satisfactory results."

By this statement of the Massachusetts Commission we should be willing to abide; that there is no reason for compulsory legislation unless the circumstances are of a nature so exceptional as to justify it. The only justification for it would be that the railroad companies will not voluntarily protect their employés from injury while coupling cars by the adoption of some safety coupler which has been proven in actual service to serve this purpose. This the companies, members of our Association, have already done without compulsory legislation. But some earnest and sincere friends of railroad employés who admit this say that compulsory legislation is needed to enforce the adoption of the Master Car Builders' Coupler upon that minority of railroad companies which stand out against it. To this we reply that, judging of the future by the past, we do not agree in this opinion. We can refer them to the change of gauge of track on the Southern roads, a change of nearly 25,000 miles, substantially in a single day, brought about by organized action of the railroad companies themselves and without compulsory legislation. We can also point to the general adoption of the Master Car Builders' type of coupler on passenger trains—brought about also without compulsory legislation. We say to them that it was only a year or more ago that the freight coupler problem actually passed out of the experimental stage; that already it has been placed on about one-fifth of the cars in service, and perhaps on four-fifths of the cars now under construction. We may add that, when the time has come that those railroad com-



BELT-TIGHTENER AND OVERHEAD ARRANGEMENT FOR MILLING MACHINE.

panies which have urged this reform are themselves in a position to insist upon it, they will decline to receive any freight car not equipped with the Master Car Builders' type of coupler, as they do to-day with passenger cars. All that is now required to side-track a passenger car not so equipped is the car inspector's chalk mark, and that is all the compulsory legislation that we think will be necessary to side-track a freight car when the time has arrived to insist upon it.

If we are asked how long this desirable result is to be delayed, we must each give his individual opinion, for, after all, it must be a matter of opinion. Answering for myself, I will say, substantially, in less time than any advocate of compulsory legislation will insist upon. The good work is going on at an accelerating speed. While a year ago the Master Car Builders' Coupler was rarely seen on a train, now it is the exception to find a train without them. The principal manufacturers are enlarging their works to meet the growing demand. On our principal trunk lines it is the rule in repairs to use them in place of the link and pin coupler. With many companies the delay in the general adoption of the standard device comes from inability to make the necessary expenditure at once. The economic question cannot be lost sight of. In these days of a small margin between the rate per mile and the cost per mile, large expenditures cannot be made from income account, and if they must be provided for from capital account many companies must wait until there is a market

for their stocks and bonds. How could a compulsory statute with a penal provision be made to apply to a company under such circumstances?

I have trespassed upon your attention beyond the usual limit of time, but I have been urged to do so by my desire to use this opportunity to defend the railroad companies against the charge of indifference to the welfare of their employés. I have sought to show that whatever has been accomplished in this matter of safety couplers has been the work of the railroad companies; that it has been accomplished as rapidly as the state of the art would permit, and that their organized action through the American Railroad Association has rendered unnecessary compulsory legislation on safety couplers.

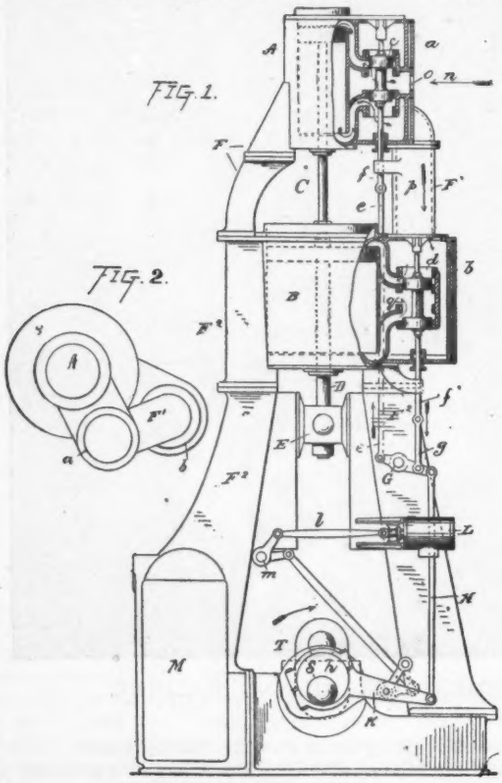
Recent Patents.

SEE'S COMPOUND ENGINE.

THE drawings herewith show an arrangement of valves for compound engines covered by patent No. 469,455, issued to Horace See, of New York, the well-known marine engineer. As shown, it is applied to an ordinary compound engine, but it is equally well adapted to a triple-expansion or quadruple-expansion engine.

In the drawings fig. 1 shows in side elevation a vertical compound engine with cylinders tandem, the steam-chests being shown in vertical cross-section, exposing the main valves to view. Fig. 2 shows in plan the relative arrangements of the cylinders and their steam-chests and the exhaust-pipe connecting the two steam-chests.

The letter *A* indicates the high-pressure cylinder; *B*, the low-pressure cylinder, of a large diameter; *C*, the piston-rod which connects the respective pistons of said cylinders, and *D*, the



SEE'S COMPOUND ENGINE.

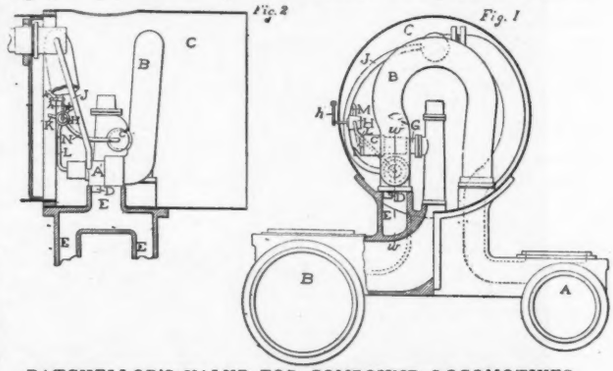
continuation of said rod, or the low-pressure piston-rod passing through the bottom of cylinder *B* and secured to the cross-head *E*. The usual connecting-rod between said cross-head and the crank *T* is omitted as unnecessary to the illustration of the invention. The two cylinders are tied together by the top frames *F* and by the exhaust-pipe *F'*, which pipe connects the respective steam-chests *a b* of the two cylinders *A B*. The housing or frames F^2 support the cylinders and all of the superstructural parts above said frames. The piston-valves *c d* are of the usual form of piston-valve, and their valve-stems *f f'* are connected by valve-rods *e g*, respectively, to arms secured on opposite sides of the beam or rock-shaft *G*. To one end or arm of said beam or rock-shaft is articulated a rod, *H*, which at its opposite or lower end is also articulated to the eccentric-rod *K*, secured in the usual manner by a strap to the eccentric *h* on the main shaft *S*. Said eccentric-rod between the eccentric and its outer end is suspended by a link on a movable center and connected by a system of rods and levers to a bell-crank or rock-shaft, *m*, which rock-shaft is connected by one of its arms and the rod *l* to the cross-head of a reversing enging, *L*. This reversing gear thus connected to said reversing engine illustrates what is known as the radial gear or so-called Marshall valve-gear. It is obvious now that upon a reciprocating motion being imparted to the rod *H* that the beam or rock-shaft *G* will be caused to vibrate upon its center, thereby reciprocating the valves *c d* by means of their respective valve-stems and valve-rods *f e f' g*, the lower valve *d* rising as the upper valve *c* descends, and *vice versâ*. The steam entering the upper steam-chest *a*, as indicated by the arrow *n*, through the nozzle *o*, will thus enter the upper cylinder through the center of the piston-valve and escape from said cylinder when exhausted at the ends of said valve, whence it passes downward, as indicated by the arrow *p*, through the exhaust-pipe *F'* into the steam-chest *b*, whence said steam enters the low-pressure cylinder *B* from the ends of the valve *d* and is exhausted therefrom through the central portion of said valve, as indicated by the arrow *q*, into the condenser or into the atmosphere, as may be desired. In fig. 1 the exhaust-steam passes around the cylinder *B* into the rear frame F^2, which, as a hollow column, serves to conduct the exhaust-steam downwardly into the condenser *M*.

The advantages of this gear are the simplicity and convenient arrangement of the parts, and the fact that none of the packing in any of the valve-stem stuffing-boxes is subjected to the high pressure of the steam coming direct from the boiler, but to only the pressure of the steam after having been at least once exhausted after doing work in a cylinder. This is due to the admission of the initial high-pressure steam only into the interior of the valve of the high-pressure cylinder.

BATCHELLOR'S VALVE FOR COMPOUND LOCOMOTIVES.

The drawings given here show a valve for compound locomotives which is used by the Rhode Island Locomotive Works, and which is covered by patent No. 459,851, issued to C. H. Batchellor, of Providence, R. I.

Fig. 1 is a front view, partly in section, of a locomotive engine, showing these improvements applied thereto. Fig. 2 is a side elevation of the forward end of a locomotive engine, showing the arrangement of the parts embodying the invention. Fig. 3 is a central longitudinal section of a portion of the re-



BATCHELLOR'S VALVE FOR COMPOUND LOCOMOTIVES.

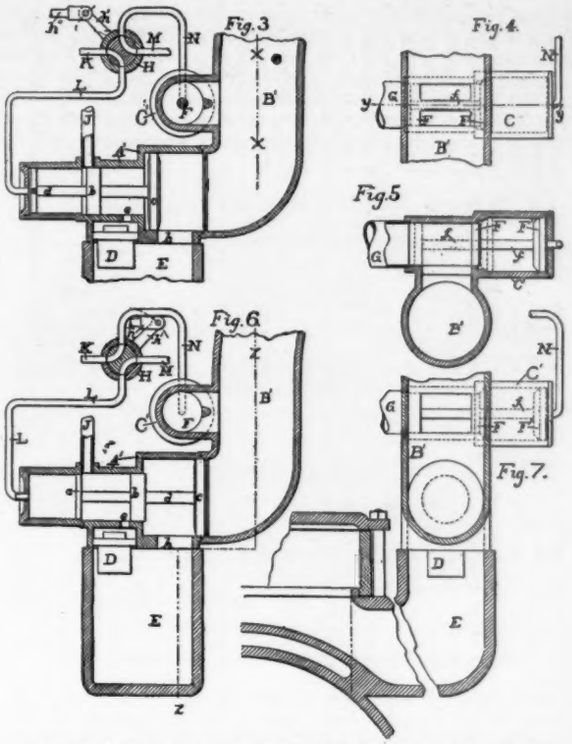
ceiver which connects the high and low-pressure cylinders and of the mechanism connected therewith, the section being taken on the line *w w* of fig. 1. Fig. 4 is a section through the receiver on the line *x x* of fig. 3. Fig. 5 is a section taken on the line *y y* of fig. 4. Fig. 6 is a central longitudinal section of the receiver and connected mechanism corresponding to fig. 3, but showing the operative parts in another position; and fig. 7 is a section taken on the line *z z* of fig. 6.

A represents the high-pressure cylinder and *B* the low-pressure cylinder, which are of different diameters and arranged upon opposite sides of the engine, as common.

Arranged within the smoke-box *C*, and leading from the exhaust-port of the high-pressure cylinder to the steam-chest of the low-pressure cylinder is the connecting pipe or receiver *B'*. Connecting with the receiver *B'* is a cylindrical chamber, *A'*, in which are arranged to work three piston-valves *a b c* of different diameters, all secured to a common valve-rod, *d*, as shown in figs. 3 and 6. Communicating with this chamber is a pipe, *J*, which connects with the main steam-pipe. Arranged at the

side of the receiver B' is another cylindrical chamber, C', within which work two piston-valves $F\,F'$ of different diameters, both mounted on a common valve-rod, f, as shown in fig. 5. A pipe, G, communicating with the chamber C', leads to the atmosphere.

H is a four-way controlling-valve, which has four pipes,



BATCHELLOR'S VALVE FOR COMPOUND LOCOMOTIVES.

$K\,L\,M\,N$, communicating therewith. The pipe K leads to the atmosphere; the pipe L communicates with the chamber A', as shown in figs. 3 and 6; the pipe M communicates with the boiler, and the pipe N communicates with the chamber C'. Said controlling-valve, H, is provided with a handle, h', which may be operated by means of a rod, h^2, extending to the cab.

E is a steam-pipe, which communicates with the steam-chest of the low-pressure cylinder, and e is an opening through the wall of the chamber A', which communicates with the steam-passage E through a reducing-valve, D, said reducing-valve being preferably of a character to reduce the steam from the boiler in proportion to the difference between the areas of the pistons of the high and low-pressure cylinders, respectively; h is another opening through the wall of the chamber A' for connecting the pipe E with the receiver B', as shown in figs. 3 and 6.

The changes in operation described below may be made automatically at certain pressures, or by the action of the engineer.

In operation, when the throttle-valve is opened, the valves a, b and c will be thrown into the position shown in fig. 6, and steam direct from the boiler will be admitted to the steam-chest of the low-pressure cylinder, somewhat reduced in pressure, however, by the reducing valve D. Both cylinders will then work at high pressure until the accumulated exhaust in the receiver B' reaches a determined pressure, when the valves a, b and c will be thrown back into the position shown in fig. 3, and the engine will work as a compound.

This illustration shows the object of the valve, which is to enable the engine to use high-pressure steam in both cylinders when needed, and to work as a compound at other times.

Foreign Naval Notes.

THE new cruiser *Thule* was recently launched in Sweden. She is an armored cruiser of 3,070 tons displacement, and of the low freeboard turreted type. The armament will include two 25-cm. and four 15 cm. guns, several light small rapid-fire guns and a torpedo tube.

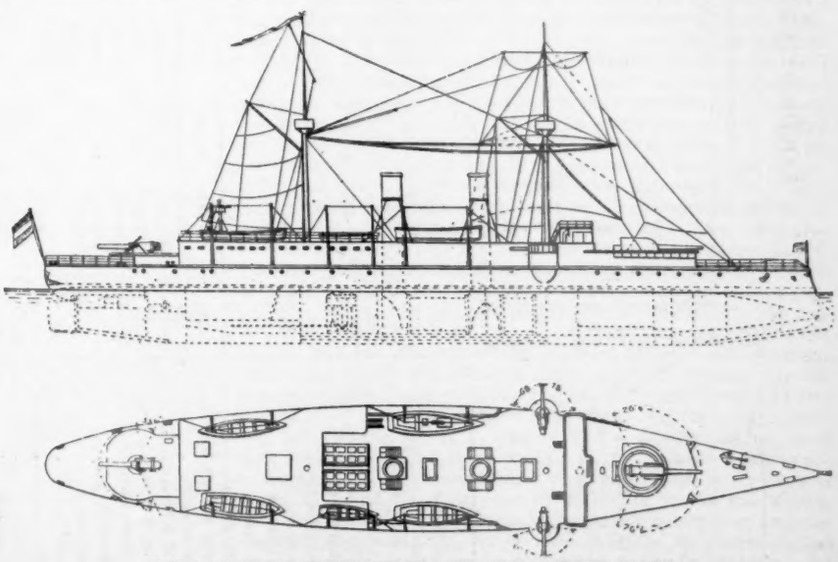
THE Japanese Government has decided to order from Sir W. G. Armstrong & Company, at Elswick, England, a cruiser of about 3,600 tons displacement. This ship is to have engines of 15,000 H.P., and a contract speed of 23 knots an hour.

ONE of the largest battle-ships of the English Navy, the *Ramillies*, was launched recently from the yard of J. & G. Thomson, at Clydebank, England. She is one of the eight ships authorized in 1889, four of which are being built by contract, and the remaining four in English dockyards. She is an armored battle-ship 380 ft. long, 75 ft. beam, and 27 ft. 6 in. mean draft, having 14,150 tons displacement, and engines which are expected to give her a speed of 17½ knots. The protection consists of a belt of compound steel plates 250 ft. long, 8½ ft. wide, and 18 in. thick, with transverse armor bulkheads fore and aft of the machinery space, and a steel deck 3 in. thick. Above this there is a second belt plate of 4-in. steel plates for a length of 150 ft. amidships. The armament will consist of two 13½-in. 67-ton guns, mounted in two barbettes rising several feet above the upper deck, composed of compound plates 18 in. thick. In addition to these, there will be ten 6-in. rapid-fire guns, 25 small rapid-fire and machine guns, and seven torpedo-tubes. The two screws will be driven by two triple-expansion engines having cylinders 40 in., 59 in., and 80 in. in diameter and 51 in. stroke, and there will be 8 boilers working at 150 lbs. pressure. The *Ramillies* will have two masts, each provided with fighting tops.

A DUTCH CRUISER.

The accompanying illustrations, from *Industries*, are a side elevation and deck plan of the cruiser *Sumatra*, lately completed at Amsterdam, and intended for service in the East Indies. She is a steel cruiser with a protective deck covering the engines, etc., while further protection is given by a belt of cellulose extending the whole length of the ship, and by the arrangement of the coal bunkers. The dimensions are: Length over all, 233 ft.; beam, 37.5 ft.; depth, 23.3 ft.; mean draft, 14 ft.; displacement, 1,703 tons. The armament consists of one 21-cm. (8.3-in.) gun forward; one 15-cm. (5.9-in.) gun aft, and two 12-cm. (4.7-in.) guns mounted in sponsons, one on each side. There are also several small rapid-fire guns and two torpedo-tubes.

The *Sumatra* has two screws, each 9 ft. diameter. There are two vertical triple-expansion engines, with cylinders 25 in., 35 in. and 55 in. in diameter and 22 in. stroke. There are two double-ended boilers 11 ft. in diameter and 17 ft. long,



NEW CRUISER "SUMATRA" FOR THE DUTCH NAVY.

and one single-ended, 11 ft. in diameter and 10 ft. long.

On the trial trips the engines showed 2,247 H.P., and a speed of 15.5 knots with natural draft. With forced draft they developed 2,749 H.P., and a speed of 16.3 knots was reached.

LOCOMOTIVE RETURNS FOR THE MONTH OF JANUARY, 1892.

Name of Road.	Number of Serviceable Locomotives on Road.	Number of Locomotives Actually in Service.	Locomotive Mileage.					Av. Train.		Coal Burned per Mile.						Cost per Locomotive Mile.							Cost per Car Mile.		Cost of Coal per Ton.
			Passenger Trains.	Freight Trains.	Service and Switching.	Total.	Average per Engine.	Passenger Cars.	Freight Cars.	Passenger Train Mile.	Freight Train Mile.	Service and Switching Mile.	Train Mile, all Service.	Passenger Car Mile.	Freight Car Mile.	Repairs.	Fuel.	Oil, Tallow and Waste.	Other Accounts.	Engineers and Firemen.	Wiping, etc.	Total.	Passenger.	Freight.	
										Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	$
Alabama Great Southern	64	53	51,200	85,296	32,202	168,208	3,183	....	....	....	....	....	79.68	....	6.69	5.20	5.60	0.23	0.40	6.30	2.00	19.73	....	...	....
Alabama & Vicksburg	19	16	18,473	14,942	12,068	45,483	2,843	....	....	....	....	...	70.42	....	6.57	2.80	6.00	0.24	0.80	6.10	0.60	17.54	....	....	....
Atchison, Top. & Santa Fé	708	....	.....	.....	325,608	1,981,531	2,799	....	....	...	....	....	90.21	....	....	5.79	7.89	0.30	0.20	6.80	1.73	22.71	....	. ..	1.67
Beech Creek	35	29	15,794	67,343	19,400	101,937	3,515	. ..	39.30	49.00	102.88	83.33	91.12	....	...	2.22	5.69	0.44	....	5 31	0.60	14.26	....	...	1.25
Canadian Pacific	580	....	481,548	913,956	285,517	1,681,021	2,898	....	....	....	....	....	80.40	....	....	3.77	14.32	0.46	..	5.52	1.33	25.40	...	2.25	3.52
Chic., Burlington & Quincy	494	..	.....	.....	.....	1,839,609	3.727	4.74	16.84	....	....	....	94.79	....	....	4.67	6.77	0 23	0.44	6.81	....	18.92	....	....	1.41
Chicago & Northwestern	846	....	650,823	1,329,165	609,558	2,589,546	3,061	....	....	....	....	....	89.93	....	.	3.57	8.53	0.37	....	6.28	0.89	19.64	....	....	1.88
Cincinnati Southern	106	102	79,618	162,563	69,314	311,495	3,054	....	....	....	....	....	88.89	....	7.38	4.00	5.90	0.26	0.80	6.50	1 60	19.06	....	....	....
Cleve., Cinn., Chic., & St. L.	...	478	419,497	652,013	355,321	1,426,826	2,985	4.30	19.80	81.73	124.84	73.58	98.96	18.62	6.31	2.96	6.57	0.19	1.63	6,64	0.21	18.20	.. .	....	1.31
Cumberland & Penn.	23	21	5,154	31,057	.....	36,211	1,724	. ..	....	....	....	....	90.90	.. .	....	6.65	4.90	0.40	....	....	2.10	14.05	....	....	....
D., L. & W., Main Line	207	198	.....	.....	.....	575,029	2,904	....	....	....	....	....	94.34	....	...	3.53	6.86	0.39	...	5.61	....	16.39	....	....	....
Morris & Essex Div.	156	....	161,293	254,354	12,255	427,902	2,743	....	....	..	....	....	64.17	....	....	3.38	10.00	0.53	....	6,26	....	19.97	....	....	3.08
Flint & Père Marquette.	....	....	87,828	157,794	54,054	299,676	..	....	....	....	....	....	52.63	....	....	2.42	6.95	0.33	....	6.15	....	15.85	....	....	2.00
Kan. City, F. S. & Mem.	150	...	102,899	271,486	125,671	500,056	3,334	....	....	.. .	....	....	68.33	....	....	3.18	5.94	0.24	0.54	7.09	....	16.99	....	....	1.69
Kan. City, Mem. & Birm.	41	41	37,317	61,616	7,110	106,043	2,586	...	....	...	....	....	70.80	....	....	3.03	3.49	0.82	....	6.85	....	14.19	....	....	0.95
Lake Shore & Mich. South.	570	560	434,182	905,033	584,144	1,923,359	3,374	....	....	71.20	97.75	38.76	74.07	....	....	2.79	5.89	0.11	0.06	7.31	0.17	16.33	....	....	1.58
Louisville & Nashville	....	369	419,394	800,159	369,532	1,589,085	3,608	5.01	15.08	66.33	116.98	51.21	86.50	13 35	7.47	4.85	6.94	0.26	1.50	6.15	0.64	20.34	3.30	1.60	1.59
Manhattan Elevated	...	282	777,181	. .....	64,595	841,776	2,985	..	....	....	....	....	46.51	....	....	1.80	9.40	0.30	....	8.70	....	20.20	....	....	3.97
Mexican Central*	146	120	....	.....	....	396,523	3,304	....	....	...	....	....	64.56	....	....	5.06	17.02	0.42	0.15	5.97	0.93	29.55	....	...	5.60
Mil. L. S. & West.	112	101	76,730	144,411	63,181	284,322	2,815	....	.. .	...	....	....	89.24	....	....	3.24	13.52	0.27	....	6.34	0.98	24.35	....	..	3.00
Missouri Pacific	339	....	.....	.....	....	1,154,960	3,407	4.24	17.32	....	....	....	101.21	19.61	7.02	4.66	7.20	0.33	1.36	6.66	1.39	21.60	4.69	1.43	1.41
N. O. & Northeastern	38	31	27,172	53.737	24 357	105,266	3,396	....	....	....	....	....	80.32	....	6.14	4.30	7.50	0.26	0.90	6.50	1.50	21.06	....	....	....
N. Y., Lake Erie & West.	....	618	436,964	1,010,162	315,199	1,762,325	2,852	4.60	19.40	94.50	137.30	77.70	...	20.70	7.10	4.91	7.98	0.42	2.48	7.37	1.16	24.32	...	1.97	1.38
N. Y., Pennsylvania & Ohio	....	261	140,539	435,213	141,375	717,127	2,748	5.10	16.50	87.60	133.00	74.20	....	17.00	8.00	4.37	7.09	0.32	3.30	6.91	1.09	23.08	....	2 09	1.25
N. Y., Prov. & Boston	....	91	103,249	46,858	58,074	208,181	2,288	....	....	...	....	....	53.53	...	....	2.88	10.59	0.52	....	6.61	0.95	21.55	....	....	....
Old Colony	....	213	301,469	115,785	114,863	532,117	2,494	...	....	...	....	....	61.61	....	....	3.32	11.55	0.65	. .	6.90	0.82	23.24	....	....	3.75
Philadelphia & Reading	....	....	440,065	775,455	512,031	1,727,551	....	.. .	....	...	....	....	84.80	....	...	4.33	4.75	0.33	....	5 75	0.39	15.55	....	....	...
South. Pacific, Pacific Sys.	....	700	.....	..... .	.....	1,619,598	2,314	...	....	...	....	....	66.65	....	...	5.08	18.30	0.38	1.74	7.33	1.86	34.69	....	....	5.70
Union Pacific	1032	...	763,104	1,531,500	555,856	2,850,460	2,762	5.08	16.09	....	....	....	107.00	17.39	9.01	7.36	8.33	0.45	0 91	8.12	1.07	26.25	4.44	2.08	1.55
Vicksburg, S. & P.	24	14	17,556	9,392	9,121	36,069	2,576	....	....	....	....	....	68.26	....	7.00	5.10	8 90	0.23	0.70	6.20	2.40	23.53	...	....	...
Wabash	....	....	.....	....	.....	.....	....	....	....	...	....	....	....	....	....	....	....	....	....	....	....	...	....	....	....
Wisconsin Central	159	140	135,365	243,685	54,890	433,940	3,099	....	....	....	....	....	92.47	....	....	3.79	11.37	0.26	....	7.17	....	22.59	....	....	2.41
Year ending Dec. 31, 1891.																									
Del. L. & W., Main Line	208	206	.....	... .	.....	7,377,912	35,815	....	....	....	....	....	84.28	....	....	3.37	6.49	0.42	...	5.85	...	16.13	....	....	....
L. S. & Mich. South.	560	539	4,887,406	8,583,727	6,220,942	19,692,075	36,525	....	....	62.56	91.41	35.45	66.84	....	....	4.66	5.18	0.16	....	6.91	0.19	17.10	....	....	1.55
Mexican Central*	140	115	.....	.....	.. ..	4,678,144	40,679	....	....	...	...	....	61.64	....	....	5.24	17.81	0.55	0.25	6.29	0.94	31.08	.. .	...	5.73

* The Mexican Central Railroad reports 16.6 units of work per $1 of expense ; 172.4 units of work per ton of coal ; 11.6 lbs. of coal per unit of work. The unit of work is 100 gross tons hauled one mile in one hour on a straight and level track. For the year 1891 the report shows 16.6 units of work per $1 of expense ; 171.3 units of work per ton of coal ; 11.7 lbs. of coal per unit of work.

Manufactures.

The Meneely Tubular Journal Bearing.

THE accompanying illustrations show a new form of journal bearing, in which the ordinary lubricating box is replaced by steel rollers. Fig. 1 is a general view of the whole bearing, and fig. 2 is a section showing the arrangement of the rollers.

This bearing is composed of steel tubes *I R* grouped closely, though not in contact with each other, about and in alignment with the journal and enclosed within a steel-lined cylindrical

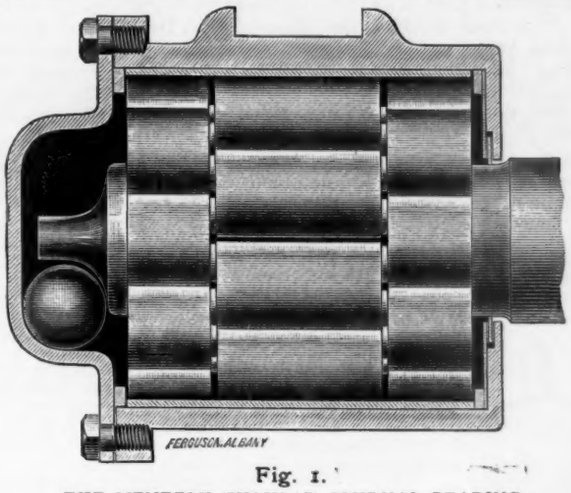


Fig. 1.

THE MENEELY TUBULAR JOURNAL BEARING.

housing or journal-box *H*. These tubes are arranged longitudinally in three series, the center series being of double length. Each short tube is in axial line with the corresponding tube of the opposite end series, while exactly intermediate to these end lines are arranged the axes of the center series. Every center tube, therefore, overlaps the adjacent end tubes. Through the alternating, opposite concavities thus formed by the interiors of the tubes, strong rods *R'* of steel are passed which lock the

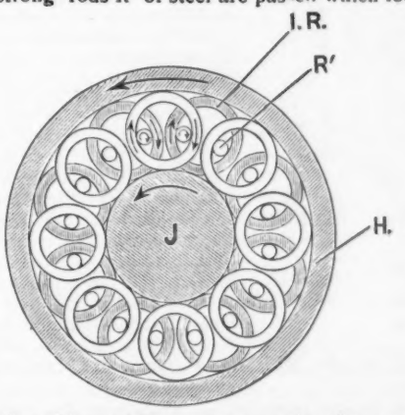


Fig. 2.

rollers in fixed position with respect to each other, and are, themselves, reciprocally held by the rollers. The arrows in

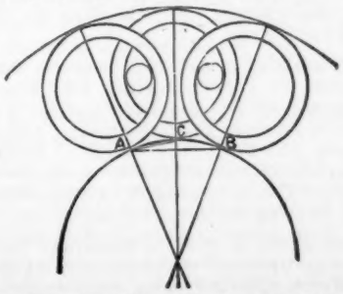


Fig. 3.

fig. 2 show the directions in which the axle and the rollers respectively revolve.

The advantage gained by the intermeshed tubular rollers is shown by fig. 3. When full length rollers were employed the adjacent bearing lines were at the points *A* and *B*; while that portion of the journal included between its perimeter and the chord *A B* represents the destructive wedging force exerted, and which had hitherto been one of the obstacles to the construction of a successful roller bearing. By making the rollers in sectional lengths, and so placing them that they break joints, intermediate bearing lines are created, as at *C*, thus securing the practical continuity of the bearing and reducing the wedge line to the chord *A C*, which is nearly coincident with the curve of the journal.

The bearing is certainly simple in form, and includes very few parts. The tubes are of steel of the best quality, and are of sufficient strength to resist crushing.

The end thrust of the axle is provided against by receiving its impact upon a steel ball seated in a groove formed in the head of the journal-box or housing, and a corresponding recess in the end of the journal, so that every movement of the journal is controlled by rolling appliances.

This bearing, which is made by the Meneely Bearing Company, of West Troy, N. Y., has been carefully tested in service. The Albany Railway has had 32 of its heavy electric cars fitted with these bearings, with results so satisfactory that 10 more have recently been added to the number.

Baltimore Notes.

THE arch-work in the Howard Street tunnel of the Belt Railroad, between the German Street and Saratoga Street shafts, has been completed. The tunnel is now finished from Lombard Street to a point north of Franklin Street, a distance of more than 2,700 ft. Work is in progress on the east wall of the tunnel south of Lombard Street, an opening having been made at the corner of Liberty and Lombard. The west wall from Lombard to Dover Street has been finished. When the east wall is built the arch will be put on by taking up the bed of the street, connecting the tunnel with the open cut south of Camden Street. There are now only five headings available from the ground work in the main tunnel, north and south from Preston Street shaft, north and south from Madison Street shaft, and north from Franklin Street. It is expected to complete the road within the year. Representatives of foreign holders of Baltimore & Ohio securities have been inspecting the road during the past two days. They are surprised at the large amount of work that has been done, and speak with praise of the engineering skill displayed in the construction of the tunnel. They speak approvingly of the strength and solidity shown in every part of the structure. Mr. H. B. Reid, Chief Engineer to the contractors, took the party through the tunnel, every detail of which was carefully examined.

THE Central Railroad Company has awarded the contract for the entire electrical equipment of its line to Mr. Davies Murdoch, representing the Thompson-Houston Electric Company. The contract for rails has been given to the Johnson Company, of Johnstown, Pa. The construction of the road will be commenced at once, and it is hoped to have it operated in July. The electrical equipment contract includes motors, generators, and line work. Some 20 motor cars will be placed on the road to be run at intervals of three minutes. Each car will be supplied with two 25-H.P. motors of a new type, waterproof and ironclad. The speed will be 10 miles an hour. Each car will hold more than 100 persons. The heaviest grade of rails—80 lbs. to the yard—has been selected. The car-stable on East Preston Street will be transformed into a power-house. The roof will be raised and the interior remodelled. The waiting-rooms and offices will occupy the front of the building on Preston Street. In the rear of the apartments will be the car-house for storing cars not in use. Separate compartments will be provided for the generators, engines, boilers, and coal-bins. The boiler-room will contain three 300-H.P. boilers. In the generator-room there will be one 200-H.P. generator and two of 250 H.P., the latter coupled together. In the engine-room will be a single 250-H.P. engine and a double engine, each unit of which will be rated at 250 H. P. All the engines are compound. The arrangement of engines and generators is made to avoid delay in case of accidents to the machinery. The single engine will operate the single generator, and the coupled generators can be worked together or singly by the double engine, which can be worked as one or in sections. An improved switch-board and lightning arresters will be included in the equipment.

WORK on the Madison Avenue line of the City Passenger Railway Company is advancing well. All the iron work on the west track is completed from Druid Hill Park to Eutaw

Street, and the paving has been done as far as North Avenue. The west track will be completed to Baltimore Street, and then the east track will be taken up. E. D. Smith & Son, the contractors, expect to build from 1,500 to 2,000 ft. of track a day when the weather is favorable and two gangs of workmen can be employed. The work on the cabling of the Blue Line, it is stated, will commence July 1.

THE Maryland Steel Company at Sparrow's Point has established a code of weather signals, by means of the big steam whistle at the iron ore furnaces, so that the residents of the Point and the farmers on Patapsco Neck for miles around can be informed of the probable condition of the weather for the next 24 hours. The company receives the weather bulletin from Washington daily, and shortly after the hour of noon the whistle announces the probabilities by the following code: One long blast, fair weather; two long blasts, rain or snow; three long blasts, local rain; one short blast, lower temperature; two short blasts, higher temperature; three short blasts, cold wave coming.

These signals are now in operation. The system, it would seem, might be useful in other places.

A New Sight-feed Lubricator.

THE illustrations below show a sight-feed lubricator for locomotive cylinders made by the Michigan Lubricator Company, of Detroit. Fig. 1 is a side view, showing the manner of attachment to the boiler, and fig. 2 is a front view. The different

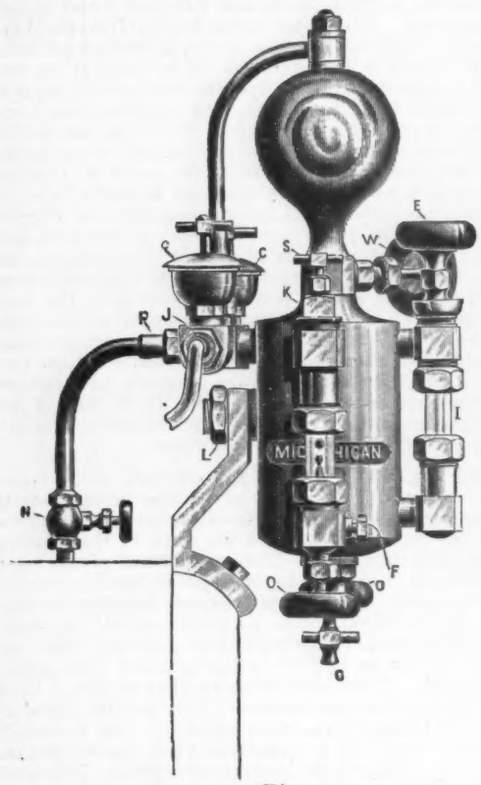


Fig. 1.

THE MICHIGAN SIGHT-FEED CYLINDER LUBRICATOR.

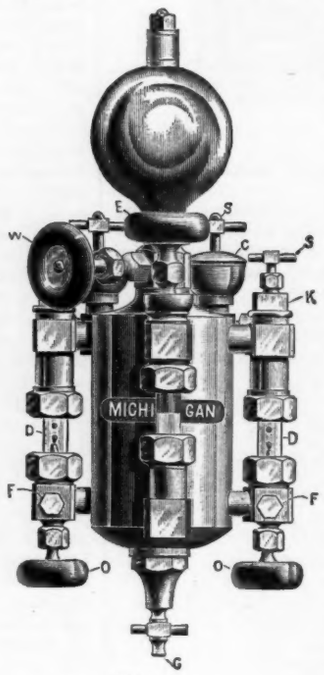


Fig. 2.

parts, as designated by the letters of reference, are as follows: *L*, lock nut to secure lubricator to angle iron; *P*, union to connect pipe for admission of steam; *J J*, unions to connect oil discharge arms with tallow pipes; *E*, filler plug; *N*, steam valve for boiler pressure; *W*, valve to admit water from condenser to oil reservoir; *S S*, lifting stems to hold check valves off their seats so that glasses will fill automatically with water of condensation; *O O*, regulating feed valves; *C C*, auxiliary oilers, entirely independent of lubricator; *F F*, valves to drain sight-feed glasses; *G*, valve to drain lubricator; *K K*, removable plugs or renewing or cleaning sight-feed glasses; *I*, gage glass; *D D*, sight-feed glasses.

The advantages claimed for this device are that it has drain valves at the bottom of the sight-feed glass, which will allow the engineer to drain the glasses and refill them with fresh condensation automatically, without first emptying the oil reservoir; it has check valves at the top of the sight-feed glass to close automatically should the glass break; it has means to hold the valves off their seats when it is desirable to rush steam through the glasses; it employs neither external nor internal equalizing tubes; it gives continuous equalizing and unvarying feed whether the throttle-valve is open or closed; it feeds its oil against continuous boiler pressure; finally, the glasses can be easily and quickly renewed.

General Notes.

THE Duncan Locomotive & Car Brake Company has been organized in East St. Louis to manufacture brakes and other appliances.

THE Steel Works of the West Superior Iron & Steel Works, West Superior, Wis., are now in operation, having been running the converters for some little time. The Company will manufacture Bessemer steel plate and structural shapes. The plant was built by the Pittsburgh Iron & Steel Company, and Mr. W. F. Mattes has charge of its operation.

THE Baldwin Locomotive Works, in Philadelphia, have an order for 21 compound engines of the Vauclain type for the Philadelphia & Reading Railroad.

THE Barney & Smith Manufacturing Company, in Dayton, O., are building 1,000 box cars for the Cleveland, Columbus, Cincinnati & St. Louis Railroad.

THE Lehigh Valley Car Works, at Stemton, Pa., are building 1,250 freight cars for the Central Railroad of New Jersey.

THE car works of Pennock Brothers, at Minerva, O., are building a number of coal cars for the Cleveland & Canton road.

THE Brooks Locomotive Works are building 20 ten-wheel locomotives with 18 × 24-in. cylinders for the Atchison, Topeka & Santa Fé Railroad.

AMONG recent orders placed with the Baldwin Locomotive Works, in Philadelphia, are 50 freight engines for the Missouri Pacific and 25 for the Norfolk & Western Railroad. It is stated that 5 of the Norfolk & Western engines are to be Vauclain four-cylinder compounds, and these engines are to receive a careful test in the service of that road.

THE Schenectady Locomotive Works are building a new foundry 100 × 346 ft. in size. The building is of iron, and will be put up by the Phenix Iron Company. The foundry will have three cupolas, and will be provided with a 15-ton Sellers traveling crane with an electric motor, and three 10-ton jib cranes. The building occupied for a foundry at present will be added to the machine shop as soon as the new foundry is finished. It is stated that these works now have contracts for 35 two-cylinder compound engines with the Pitkin valve, intended for different roads.

THE Berlin Iron Bridge Company, East Berlin, Conn., is building a new machine shop for the Worthington Hydraulic Works, in South Brooklyn, N. Y. The building is 200 × 50 ft., and will have a Sellers traveling crane, which will run the whole length of the shop.

THE Long Island Railroad Company has ordered from the Baldwin Works 10 Forney engines for suburban business. These engines will have four cylinders of the Vauclain type, 9 in. and 15 in. in diameter by 20 in. stroke. The driving-wheels will be 51 in. in diameter. The weight in working order will be 60,000 lbs., of which about 42,000 lbs. will be carried on the driving-wheels. The boilers will be 44 in. in diameter, and will be built for a working pressure of 180 lbs.

THE Robert Poole & Sons Company, of Baltimore, is engaged in some important contracts, and the shops are very busy. The Company is furnishing the plant for the extension of the Washington & Georgetown cable road; also that for the extension for the Baltimore Traction Company's cable line. The shops recently turned out some very large gearing for the

Detroit Brass & Copper Works, and are doing some work for the turrets of the new battle-ship *Texas*.

THE shops of Bement, Miles & Company, in Philadelphia, have recently completed a very large vertical and horizontal planing machine for the Newport News Ship Building Company. In this machine the cutting tools have a vertical movement of 21 ft. and a horizontal movement of 23 ft. It is intended for planing steel plates, and occupies a floor space of 30 × 40 ft., and is 33 ft. high from the ground to the apex. The same firm recently built for the Newport News Company a lathe which will swing 10 ft. 6 in. in diameter and 40 ft. between centers. This tool is to be used for turning large shafts and cranks. They are also building a set of rolls for the same yard, which will be capable of bending plates 32 ft. long and 1¼ in. thick.

THE Gould Coupler Company has had plans prepared for new and extensive shops at the new town of Depew, near Buffalo. The Company intends to have one of the largest malleable iron plants in existence. The foundry will be 660 ft. × 82 ft.; the annealing room 520 × 82 ft., and there will be a number of smaller buildings, including pattern shop, machine shop, engine room, etc. The buildings will be of brick with slate roofs. The Company has secured about 50 acres of land.

THE Union Iron Works, San Francisco, recently launched a light-ship with steel frames planked with Oregon pine, sheathed with oak, and coppered. She is 112 ft. long, 27 ft. 8 in. beam, and 12 ft. 8 in. in depth, and is very strongly built.

THE Cooke Locomotive Works, Paterson, N. J., have received a large order for new locomotives for the Louisville & Nashville Railroad.

THE Pittsburgh Locomotive Works have recently built a number of engines for the Manhattan Elevated in New York. They are building several heavy passenger engines for the Pittsburgh & Lake Erie Railroad.

THE Safety Car Heating & Lighting Company has recently equipped with its heating systems 50 cars on the New York, Lake Erie & Western; 20 on the Central Railroad of New Jersey, and 25 for the Wagner Palace Car Company.

THE Dickson Manufacturing Company, Scranton, Pa., is building 4 consolidation engines for the New York, Ontario & Western, and 8 for the Delaware, Lackawanna & Western Railroad.

THE Rhode Island Locomotive Works, in Providence, R. I., are building 27 passenger and 7 freight engines for the Boston & Albany, and 13 passenger engines for the New York, New Haven & Hartford. They have also orders on hand for the Wabash and the Union Pacific.

THE first large steamer built by the Newport News Ship Building Company was launched from that Company's yard March 16. The ship is built for the Southern Pacific Company, and is named *El Sud*. She is an iron ship, 380 ft. long at the water-line, 406 ft. over all, 48 ft. beam, and 39 ft. depth of hold. She has a single propeller driven by a vertical triple-expansion engine, with cylinders 32 in., 52 in., and 84 in. in diameter and 54 in. stroke, and furnished with steam by three double-ended cylindrical boilers, each having six corrugated furnaces.

THE William Cramp & Sons Ship & Engine Building Company in Philadelphia, is adding to its works the necessary tools for assembling and finishing guns up to and including 5 in. caliber. Projectiles will also be manufactured.

THE Union Iron Works, San Francisco, are building a new steamer for the Pacific Mail Steamship Company. This vessel is 345 ft. long over all, 45 ft. beam, and 27½ ft. depth of hold. She will have a triple-expansion engine and six steel boilers, each 12 ft. in diameter and 11½ ft. long, built for 160 lbs. working pressure.

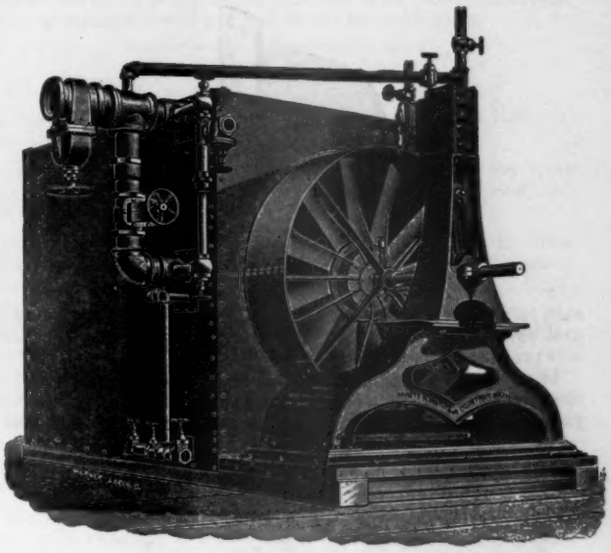
THE Erie Car Works, Erie, Pa., are at work on orders for 500 hopper-bottom gondolas and 600 box cars.

THE Harrisburg (Pa.) Foundry & Machine Company has just closed a contract to equip the new power station of the Wilkesbarre & Wyoming Valley Traction Company, at Wilkesbarre, Pa., with an entire outfit of engines, boilers, etc.

THE Pittsburgh Locomotive Works have begun the erection of a new machine shop. It will be built of brick, with iron framework, and will be 365 × 125 ft. They are also building a blacksmith shop, 365 × 100 ft., with an 80-ft. wing, which will be used for a hammer shop.

THE Harlan & Hollingsworth Company, Wilmington, Del., is building 25 passenger cars for the Illinois Central Railroad.

THE Huyett & Smith Manufacturing Company, of Detroit, recently put one of their hot-blast apparatus into the Chicago & Grand Trunk shops at Fort Gratiot, Mich. The apparatus



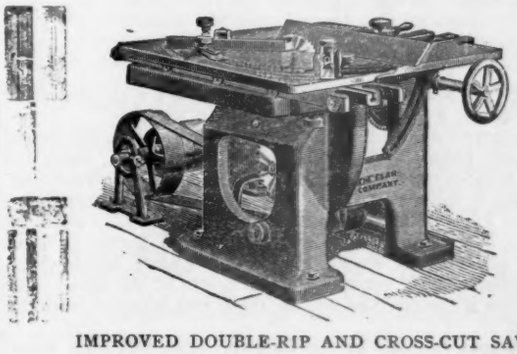
THE SMITH HOT-BLAST APPARATUS.

used has a 72-in. fan, and is capable of delivering 60,000 cub. ft. of air per minute; the fan is run by a vertical high-speed engine directly attached. The main shop is 90 × 400 ft., and the heated air is forced directly into one end of the room. The plan has proved an entire success. In this case no pipes are used to distribute the air, thus saving a considerable expense.

A New Saw.

THE accompanying cut shows a new double rip and cross-cut saw, designed for edging, ripping, and cross-cutting, and especially intended for pattern making and other close and accurate work. The tool can be quickly changed to suit the work wanted, and it is very simple in construction.

The column is one entire casting, with the saw mandrel arranged to revolve around a common center inside the column, so that when the ripping saw is above the table, the cut-off saw



IMPROVED DOUBLE-RIP AND CROSS-CUT SAW.

is below the table, and for grooving, either saw can be brought above the table according to the depth of groove to be cut.

The table is of iron, made in two sections, both sections planed perfectly true, and the one at the left of the saw made to work back and forth on rollers, for edging or cross-cutting. There are two miter fences for cutting right and left, and one ripping fence, all accurately fitted to the table and in line with the saw.

The mandrels are of the best quality of steel, running in self-oiling boxes lined with Babbitt, and driven from a countershaft placed clear of the column, a decided improvement.

This is a very useful and convenient tool. It has been designed and built by the Egan Company, Nos. 194–214 West Front Street, Cincinnati.

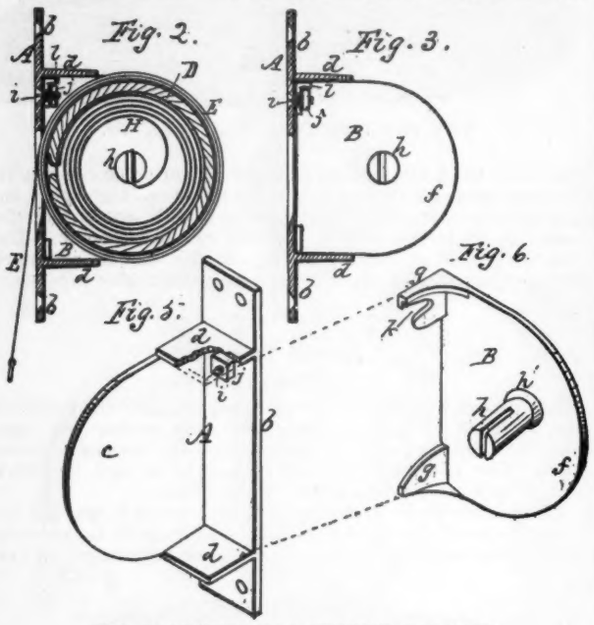
The Caldwell Car-Window Balance.

MOST travelers are well aware, by painful experience, that the old-fashioned car window is a troublesome and very imperfect device, to which are due much annoyance and a frightful amount of profanity. An arrangement which will permit the

Fig. 1.

sash to move up and down freely, and will hold it at any point desired, will be thoroughly appreciated by the wayfarer and will prevent much unreportable language.

The accompanying illustrations show a device which, it is claimed, will do this; and the claim is supported by several years' successful use. Fig. 1 is a perspective view of this bal-



THE CALDWELL CAR-WINDOW BALANCE.

ance; fig. 2 is a section; fig. 3 shows the case with the spring removed; figs. 5 and 6 show the details of the case.

In this device a coiled steel clock spring sustains the weight of the sash, giving a steady and noiseless motion, while the working is more even and smooth than that of a weighted sash. The spring is connected to the sash by a ribbon of aluminum-bronze, of great strength and durability, as this alloy does not corrode. The balance only requires a plain frame, without boxes or pockets. A set-screw in the face-plate serves to adjust the balance for a variation in the weight of the sash. The construction is simple, and will be readily understood from the drawings.

This balance is made by the Caldwell Manufacturing Company, of Rochester, N. Y., and is in daily successful use.

Strength of Cast Iron.

THE iron made in the old charcoal furnaces of the Salisbury District in Northwestern Connecticut has for many years been noted for its strength. The Landon Iron Company, which owns the furnace at Chapinville, Conn., has recently been making experiments with a view of still further improving the quality. One step taken has been to calcine the ore in kilns before its reduction in the blast furnace. A number of tests made of pig iron from this calcined ore have given a tensile strength of from 34,761 to 41,882 lbs. per square inch, the samples being broken in a Riehle Brothers testing machine. This iron is sharp grained, and in casting wheels gives a hard and dense chill, while the plates are more elastic than when the iron is made from uncalcined ore.

An Automatic Numbering Machine.

THE small illustration given herewith shows an exceedingly convenient automatic numbering machine, which is made by the Bates Manufacturing Company, of New York, and which can be used for a number of purposes, such as numbering railroad tickets, documents, or for any other purpose where consecutive numbering is desired. The machine is very small and light, weighing only about 14 oz.; works quickly and with but little friction, and yet is strong and able to stand a large amount of work. It is automatic in its operation, and requires no further attention than to set the indicator dial in the front at the proper point. As shown by the face in the engraving, it can be arranged to number consecutively, to number in duplicate or to repeat the same number, in all cases working automatically and without attention. Durability is secured by making the ratchets solid in each disk. They are milled upon their inner edges, and therefore present a wearing surface equal to the width of the wheel.

THE BATES AUTOMATIC NUMBERING MACHINE.

The inking attachment is convenient, and does not require frequent renewal. The machine has a gauge-plate by which accurate alignment can be secured.

It is made in different sizes with from 4 to 7 wheels. The largest size numbers consecutively from 1 to 9,999,999. When numbers in series are required, letters instead of figures can be engraved upon the last wheel, and so arranged as to change automatically when the numerical limit of the machine is reached. It is made with different sizes and styles of figures, and has the advantage of being lower in price than any machine of the kind yet placed in the market.

Some use of this machine upon the editorial desk shows that the claims of the manufacturers are well founded as to its convenience, handiness, and certainty of action.

Standard Couplers.

THE Committee—Messrs. John S. Lentz, J. M. Wallis, and G. W. Rhodes—appointed by the Master Car-Builders' Association, have considered it desirable to issue the following circular to all manufacturers of vertical-plane couplers for the purpose of securing uniformity in M. C. B. standards, and to determine a standard of excellence in material and design.

"For the accurate determination of the contour lines, the gauges now made by the Pratt & Whitney Company will be used. These gauges have been determined by the Executive Committee; in pursuance of the action of the Convention and the instructions transmitted by the Convention to the Committee, the standards of length, thickness, and other dimensions adopted by the M. C. B. Association, and illustrated in the announcement from the Executive Committee under date of August 1, 1891, must be strictly conformed to. The Committee further recommends the pocket or U-shaped fastening in lieu of the tail-bolt. The Committee further proposes the following specifications for the M. C. B. draw-bars:

"1. Weight. Draw-bars, including knuckles and locking attachments, should weigh 210 lbs. or less; they must not weigh over 220 lbs.

"2. All drop tests will be made on a solid masonry foundation. The knuckle of the bar to be tested will be in its closed locked position. The bottom of the drop will be flat so as to represent the blow from an opposing closed M. C. B. bar.

"3. Pulling test. Draw-bars must be constructed so that when subjected to a pulling test, they will stand not less than 100,000 lbs. In view of the rebound draft rigging is subjected to after an emergency application of brakes, the Committee will consider increasing this limit to 110,000 lbs.

"4. Drop test. Draw-bars should stand the following drop test: Weight of drop, 1,640 lbs.; 3 blows at 10 ft.; 2 blows at 15 ft. The draw-bar or knuckle must break into two or more pieces before it is considered to have failed under this test. The cracking of the parts will not be considered as a failure.

"5. In subjecting bars to tests 3 and 4, the draw-bars and knuckles will be considered separately—that is, a failure of one will not condemn the other.

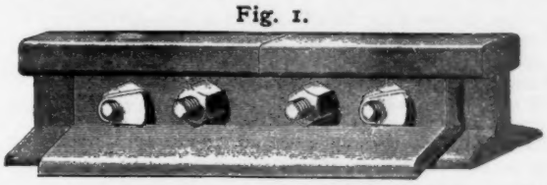
"These specifications are not supposed to be entirely accurate, but they are offered by the Committee as a step in the direction of adopting specifications which will make a standard of excellence in M. C. B. couplers."

The Young Reversible Nut-Lock.

THE drawings given herewith show a new type of nut-lock devised by Mr. Levi H. Young, of the St. John Bolt & Nut Company, at St. John, N. B. Fig. 1 shows a rail-joint with these nut-locks; fig. 2 is a view of a track-bolt with the lock attached, and fig. 3 is a separate view of the lock itself.

This nut-lock is based upon the principle that an outside lock, which will tend naturally to tighten itself continually, is the true form, especially for a rail-joint. The spring lock placed under the bolt, it is claimed, has a contrary tendency, and whatever force may be exerted by its spring will be added to the other forces which tend constantly to work the nut loose

Fig. 1.



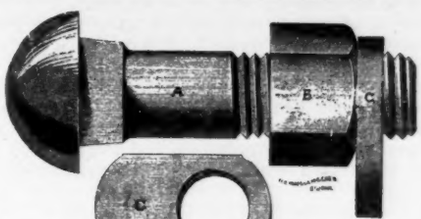


Fig. 2.

Fig. 3.

THE YOUNG PATENT NUT-LOCK.

and to injure the thread. The Young lock is so arranged that the force of gravity will continually tend to tighten it up, as the constant jarring and movement of the rail is felt. The lock being left in the position shown in fig. 1, the force of gravity would act to throw the heavy end downward—that is, to screw it up tighter and tighter. This claim seems to be well founded, as will readily be seen from an examination of the device. The lock is made of a thickness equal to $3\frac{1}{2}$ or $4\frac{1}{2}$ times the pitch of the thread, so that when screwed up on the bolt it can always be made to come into the position in which the advantage gained by gravity will come into play. If, when screwed up on the bolt, it should come into the position in which it would tend to turn off instead of on, it is simply necessary to take it off and reverse it, changing the position of the heavy side 180°. It can be applied to any rail-joint, with bolts having the usual standard thread, without removing the nuts, and, as can be seen from its construction, it can be made as cheaply in large quantities as any ordinary nut-lock.

It may be said, in effect, that this lock is an ordinary jam-nut with the addition of the extra weight, which not only prevents it from turning backward, but operates continually to turn it up and take up any slack which may result from wear.

This nut-lock has been subjected for some time to the test of actual use. About 150,000 have been in use on the Intercolonial Railway for over a year, and the Chief Engineer of that road, Mr. Collingwood Schreiber, states that it is serving its purpose very satisfactorily, and that he regards it as one of the best nut-locks ever brought to his notice. It has also been in use with very satisfactory results on the Canada Atlantic, the Nova Scotia Central, the New Brunswick Railroad, and on the Canadian Pacific in the Montreal yards. In the latter position the Yardmaster stated that a number of different devices have been tried, but that all required constant attention until this was introduced. It has also been in use on the Central Vermont and on the New York & New England experimentally with equally favorable results. It is now on trial on the New York Central & Hudson River Railroad and the Manhattan Elevated. On the former line it has been placed where there is an exceedingly heavy traffic, and the Supervisor in charge of the Grand Central Yard reports very strongly in its favor.

There seems to be no doubt that this is an excellent device, and it is especially well adapted to use on a rail-joint.

PERSONALS.

COLONEL THOMAS COGSWELL has been appointed Railroad Commissioner of New Hampshire.

GEORGE H. CORYELL has resigned his position with the West Virginia Central & Pittsburgh Railroad, and has opened an office as Consulting Engineer in Washington.

JACOB W. MILLER, formerly General Manager of the New York, Providence & Boston Railroad, has been elected Second Vice-President of the New York, New Haven & Hartford Company.

WILLIAM KIRKBY, of Toledo, has been appointed Railroad Commissioner of Ohio. He was at one time a conductor, and later Yardmaster on the Lake Shore & Michigan Southern Railroad.

JAMES E. GREENSMITH has been appointed General Manager of the Portland Company at Portland, Me. Mr. Greensmith was recently with the Pond Machine Works, but was formerly for a number of years with the late William Mason at Taunton.

WILLIAM VOSS, recently Master Car Builder of the Burlington, Cedar Rapids & Northern Railroad, has been appointed Superintendent of the works of the Barney & Smith Manufacturing Company at Dayton, O.

ALEXANDER MITCHELL has been appointed Superintendent of Motive Power and Equipment for the Eastern and Northern Divisions of the Philadelphia & Reading Lines. These divisions include the Lehigh Valley Railroad, upon which Mr. Mitchell has served for some years as Master Mechanic.

TIMOTHY HOPKINS has resigned his position as Treasurer of the Southern Pacific Company. Mr. Hopkins has presented his large library of books on railroad topics to the Stanford University, accompanying this gift with another of a large sum of money for the purpose of making a complete library, which shall include, if possible, all the books on railroads ever published.

OBITUARY.

ARIO PARDEE died suddenly at Rock Ledge, Fla., March 26, aged 81 years. He was born in Nassau, N. Y., studied engineering, and at an early age became engaged with the late Judge Asa Packer. Under his direction Mr. Pardee was engaged for a number of years in surveys for railroads in the anthracite region in Pennsylvania. The Beaver Meadow Railroad, now part of the Lehigh Valley, was built under his charge, and a number of short branches were located and constructed by him. He also laid out the town of Hazleton, Pa., about 1840. He was placed in charge of several coal mines near Hazleton, and he afterward invested largely in coal mines, gradually becoming a large owner and operator, and accumulating a great fortune. In addition to his coal mines, he was interested in the blast furnaces at Stanhope, N. J., the car shops at Watsontown, Pa., and some other manufacturing enterprises.

Mr. Pardee presented Lafayette College at Easton, Pa., with the hall bearing his name—a building erected at a cost of $350,000—and subsequently rebuilt it when it was damaged by fire. It is understood that he has left a considerable sum of money to the same college.

MAJOR H. WADSWORTH CLARKE, who died in Syracuse, N. Y., February 26, aged 54 years, was born in Harford, Pa., but at an early age removed to New York State. He received a careful training as an engineer, and when still a young man entered the office of the City Surveyor of Syracuse, and served there as assistant until 1861, when he entered the Army, serving in a New York regiment, in which he rose to the rank of Captain. After the war he was appointed City Surveyor of Syracuse, and served as such for five years. After leaving that position, he continued to practise his profession, and from 1877-86 was in charge of the surveys of the State boundary-line between New York and Pennsylvania. In 1889 he again became City Engineer, but a year later was forced to resign by ill health, which prevented him from undertaking further work.

As an engineer Mr. Clarke held high rank. He was for a number of years a member of the American Society of Civil Engineers, and was also a prominent member of the American Meteorological Society. He was also Secretary of the Onondaga Historical Society and a prominent member of other local associations. He was naturally a very energetic man, and felt severely the long illness from which he suffered.

GENERAL GEORGE STARK, who died in Nashua, N. H., April 13, aged 69 years, was born in Manchester, N. H., and was a descendant of the famous General John Stark, of Bennington. He began work as a civil engineer at an early age, and was employed in the construction of the Nashua & Lowell, the Concord, the Boston, Concord & Montreal, and the Stony Brook roads, and in the surveys of the Vermont Central and portions of the Old Colony Railroad. In 1849 he was appointed Superintendent of the Nashua & Lowell, and three years later became Superintendent of the Hudson River Railroad. In 1857 he went back to the Nashua & Lowell, and afterward was appointed to the same position on the Boston & Lowell. When the two roads were practically united he operated them as Manager under the joint agreement, and continued in that position until the agreement was terminated. Subsequently he was one of the committee which reorganized the Northern Pacific after the failure of 1873, and for a time he was Vice-President and General Manager of that road. For some years past he has retired from active work. General Stark was a prominent figure in railroad and political circles in New England for many years, and it was under his charge that the Boston & Lowell became one of the important Boston lines. He served several terms in the New Hampshire Legislature, and was a candidate for Governor of that State in 1861.

PROCEEDINGS OF SOCIETIES.

National Conference of Railroad Commissioners.—The fourth annual Conference of Railroad Commissioners met at the rooms of the Interstate Commerce Commission, in Washington, April 13. Commissioner E. P. Jarvey, of South Carolina, was chosen Chairman.

At the first session reports were presented by the Committees on Railroad Accounting and on Reasonable Rates. The latter recommended amendments to the Interstate Commerce Act providing for the trial of cases in Court on the evidence introduced before the Commission, in cases where appeals may be taken from the decisions of that body as to reasonable rates.

At the afternoon session the Committee on Use of Private Cars reported, recommending the restriction of mileage on private cars to a reasonable payment for their use when loaded; no mileage to be allowed for returning empty cars, and no discrimination to be made against shippers of any class of freight who do not furnish their own cars, railroad companies to be required to furnish them with cars as needed.

On the second day the reports of the Committees on Legislation and on Safety Appliances were read and discussed. There was also a long discussion of the report on Uniform Accounts, read on the first day. It was decided to advise Federal Legislation on Safety Appliances.

American Society of Civil Engineers.—At the regular meeting in New York, April 6, a paper was read by Mr. Willard Beahan on the Main Intercepting Sewer in Brooklyn, special explanations and diagrams being presented. The paper included a consideration of the methods of tunneling in general use, and a description of the pilot system adopted in the work described. A written discussion by Mr. A. F. Sears was read, and there was a verbal discussion by a number of the members present.

It was announced that the Directors had fixed upon the Hygeia Hotel, at Old Point Comfort, Va., as the place to hold the Annual Convention, which will begin on June 8.

The following elections were announced:

Members: E. H. Beckler, Helena, Mont.; Edward Mohun, Victoria, B. C.; S. Tomlinson, Bombay, India.

Associate Members: John S. Elliott, Jamaica, West Indies; William C. Hawley, Chicago, Ill.; Walter G. Kilpatrick, Nashville, Tenn.; Edwin Mitchell, Chambersburg, Va.; Walter F. Whittemore, Hoboken, N. J.

American Railroad Association.—The spring meeting was held in New York, April 13. The Secretary reported an increase in the membership of the Association.

The first business was the annual address of the President, Mr. H. S. Haines, which is referred to upon another page.

The Committee on Car Service made a report recommending the adoption for one year of a charge of one-half cent a mile, and six cents a day for the use of freight cars. This called out much discussion, and action upon the report was finally postponed to the next meeting.

The Committee on Train Rules reported that they had not received sufficient encouragement from correspondents to recommend any action on the adoption of the 24-hour system A number of suggestions have been received on the Standard Code of Rules, but no report was made. It is proposed, however, to hold a special session of the Association in Chicago this summer, to be devoted to considering train rules and signals.

The Committee on Safety Appliances made a report on Power Brakes, substantially recommending that all new locomotives and cars built for freight service should be fitted with such brakes, and all locomotives with driver brakes. This Committee also reported that there are now about 135,000 freight cars in service fitted with the M. C. B. type of coupler, and about 27,000 more under construction, which will have the same coupler.

The following officers were elected: President, H. S. Haines; First Vice-President, Lucius Tuttle; Second Vice-President, E. B. Thomas; Members of Executive Committee, H. F. Royce and Joseph Ramsay, Jr.

American Society of Mechanical Engineers.—The members who join in the trip to the California meeting will leave New York on May 4 by special train, and will reach San Francisco May 16, stops being made at Niagara, Chicago, Manitou Springs, Cañon City, Salt Lake and Monterey.

The excursions after the meeting will include trips to Los Angeles and Southern California, to Oregon, and to Oregon, Washington and the Yellowstone Park.

A number of good papers are announced for the meeting.

Boston Society of Civil Engineers.—At the annual meeting, in Boston, March 16, the reports showed a total of 290 members, with the treasury in good condition.

The following officers were elected for the year: President, Henry Manley; Vice-President, A. F. Noyes; Secretary, S. E. Tinkham; Treasurer, E. W. Howe; Librarian, F. W. Hodgdon; Director, Frederick Brooks.

After the business had been disposed of, Mr. Thomas C. Clarke made an address on Progress in Bridge Building, with special reference to deep foundations and long spans. His remarks were illustrated with views of a number of notable bridges.

Western Railroad Club.—At the regular meeting, in Chicago, March 15, there was an extended discussion on Mr. Forsyth's paper on the Strength of M. C. B. Couplers.

The rest of the meeting was devoted to discussing amendments proposed to the Rules of Interchange. A number were reported by the Committee, and nearly all of them were approved after discussion. Among the amendments were a general revision of the rules concerning Brakes and Draw Bars; Changes in the Prices of Wheels, Axles and Couplers. The discussion was to be continued at the next meeting.

Central Railroad Club.—At the regular meeting in Buffalo, March 23, the Committee on Steel Trucks reported that these trucks have not been in use long enough to determine their weak points and their cost of maintenance, and recommended a further trial. This was discussed at some length.

A number of proposed amendments to the Rules of Interchange were discussed, but no final conclusion was reached. A committee was appointed to confer with the Superintendents' Association and discuss some means of facilitating movement of cars employed in local freight.

Engineers' Club of Philadelphia.—At the regular meeting, March 19, Mr. Arthur Falkenau presented a paper on the Cost of Power in Mexico, and in some Western mining regions. He referred to the high cost of fuel and other supplies, and said that in Mexico labor was so cheap and fuel so dear that there was little to be gained by introducing improved machinery.

Mr. Paul A. N. Winand read a paper on the Cost of Power in Using Internal Combustion Engines. This was followed by a short discussion.

The Secretary read for Mr. Alan N. Lukens a paper on Cost of Errors in Transmission of Power, in which he cited numerous instances of erroneous transmission which had come under his observation. In summing up the evils of erroneous transmission, he said, there were to be noticed, first, the alignment of the shafting, the spacing of hangers and pulleys; second, the adjustment of the bearings, the size of the pulleys, and the tension of the belts. All these add to the power required, and

therefore cost money, as well as requiring extra time and labor, to keep them in anything like good order, and time is money, as every one knows.

This paper was discussed at some length.

AT the regular meeting, April 2, the following members were elected: Henrik V. Loss, F. V. Hetzel, Clayton W. Pike, H. M. Montgomery, C. O. C. Billberg and Charles W. Close.

Mr. W. S. Auchincloss read a paper on Yearly Tides.

In this paper the author stated that he proposed to show that confined bodies of fresh water are subject to yearly tides of greater or less magnitude, depending upon the nature of the basin or upon the strata to which they are confined, and upon the effect of evaporation if in an open basin. This was generally discussed.

Mr. Jacques W. Redway presented a paper on The Influence of Rainfall on Commercial Development, a study of the arid region, including some accounts of methods of irrigation.

The Secretary presented for Mr. George A. Bullock a large wall map, showing the street-paving of Philadelphia, which was accepted with thanks.

Mr. Mordecai's Note on Engineering Civil Service was presented by the Secretary, together with a letter giving the information relating to that portion of Ireland referred to.

The Secretary also presented from Mr. Robert A. Cummings a letter on the same subject, explaining the method of determining the necessity and placing the contracts for any work which may be desired.

Civil Engineers' Club of Cleveland.—The April meeting of the Club was held in the club rooms, April 12. Ernest C. Barth and Peter Rasch were elected active members.

The paper of the evening was read by Dr. Dayton C. Miller, of the Case School of Applied Science, on Astronomical Spectroscopy. The general theory of spectrum analysis was given, the sun being considered the typical source of energy. The spectroscope in its different forms was described, and its application to the study of solar phenomena explained. Special attention was given to a description of the new universal spectroscope recently made by Brashear for Professor Young, of Halsted Observatory of Princeton College. This instrument is more complete and perfect than any before constructed; it is adapted for either visual or photographic work on the sun, stars and comets. Professor Young has already made some excellent photographs of the spectrum of sun spots, the chromosphere and prominences, fixed stars and planets, which promise brilliant results. Solar investigations at Princeton are to be continued and the work extended to the study of stellar motion in the line of sight. Mention was made of the very valuable work of Professor George E. Hale, of Chicago, and Professor Vogel, of Potsdam. The paper was illustrated with lantern slides, many being from original negatives of recent date.

Engineers' Society of Western Pennsylvania.—At the regular meeting, April 19, Mr. George S. Davison read a paper on Discharge Observations on Large Streams, which was afterward discussed by members present.

A number of chemists of Pittsburgh and vicinity have become members of the Society, and a Chemical Section has been formed which holds regular meetings.

Engineers' Club of St. Louis.—At the regular meeting, March 16, Chancellor W. S. Chaplin was elected a member.

Mr. Arthur Winslow read a paper on the Progress of Mapping in Missouri, in which he sketched the history of map making, referring at some length to the early maps. More recently the United States Coast Survey began, in 1871, with a triangulation across the State, and in 1882 precise leveling was carried across the State. The Mississippi and Missouri River Commissions had carried the work along those rivers; and the United States Geological Survey from 1884–89 mapped about one-third of the State, chiefly in the central part. The State Geological Survey is at present engaged in mapping the State. A discussion by members present followed the reading of this paper.

AT the regular meeting, April 6, A. A. Stuart, C. B. White and T. L. Condran were elected members.

The organization of an association for the Abatement of the Smoke Nuisance was referred to.

Mr. E. A. Hermann then read the paper of the evening, on Steam Shovels and Steam Shovel Work. The steam shovel is not a very old machine; its general use dates from about 1875. The steam shovel for railroad use only differs from those for general work merely in being mounted on standard gauge trucks. The machinery of a steam shovel works either through positive gearing or through friction clutches. The latter works more rapidly and is better adapted to softer materials, but heats the clutches easily, often causing delays. The positive gearing machines are a little slower but more reliable, especially for hard material. The sketches showed manner of making cuts of different depths and widths; also showed the plow and spreader, and manner of using them, for unloading and distributing the material loaded on cars by steam shovels.

Discussion followed by Messrs. Crosby, Hermann, Ockerson and Wheeler.

Mr. Perkins described an instance of the delivery pipe from a boiler becoming choked with scale. Colonel Meier cited an instance where the intrainment was 14 per cent.

A discussion on the purification of the city water was taken part in by Messrs. Seddon, Potter and Johnson.

Professor Johnson exhibited the first scientific book on the truss bridge, entitled "Bridge Building," by S. Whipple, published in 1847.

Engineers' Society of St. Paul.—At the regular meeting, April 4, Mr. R. Davenport read a paper on the Red River of the North. This river is a ditch in the prairie, meandering on an average two miles to make one, with a discharge varying from 250 to 20,000 cub. ft. per second at Breckenridge, and from 600 to 50,000 at Pembina. The first work of improvement was begun in 1877; it was estimated to cost about $300,000, and was intended to make the river navigable for flat-bottomed craft by dredging and the removal of bank obstacles from Breckenridge to the Canada line, about 200 miles. On this $240,000 have already been expended. The banks are subject to slides peculiar to this river, banks of earth having a tendency to work themselves into the river at the level of its bed in the form of wedges extending horizontally some distance from the bank. The movements of these masses allows the surface above to settle undisturbed. The traffic on the river is wholly local, and seems to have varied with the precipitation. From 1879–82 it increased from 18,000 to 32,000 tons, then fell off to 1,700 tons in 1890, but last season again grew to 12,000 tons. The engineers' estimate is that the expenditure of $350,000 on reservoirs would make the river navigable all the year, excepting in the frozen season, while with $550,000 expended in locks, dams, and canals, the length of navigable tributaries might be doubled.

NOTES AND NEWS.

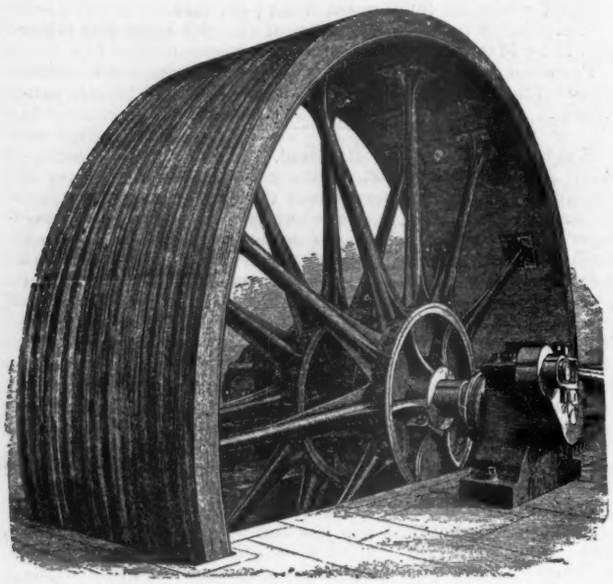
Compressed Air for Cleaning.—Compressed air for cleaning cars is used on the Union Pacific Railroad at its Portland shops. The air, under a pressure of 50 lbs. per sq. in., is delivered from a flexible hose with a small nozzle, and is used as water would be.—*Exchange.*

Earth Roads and Wagon Tires.—In an article in *Good Roads*, which ought to be read everywhere, Mr. Isaac B. Potter says: "The great destroyers of the common earth roads are water and narrow wheel tires. In the first place, those roads are, as a rule, wretchedly drained, or, in many cases, not drained at all. If a deep side ditch could be maintained on each side of the ordinary dirt road, and kept clear so as to receive and carry off the running water, the quality of the road would be improved, in most cases 100 per cent. This is a point which farmers seem to meagerly understand, or, at all events, one which they rarely put to practical use. Water has no place in any road, good or bad. It is more hurtful than any other agent of destruction. It should be carried off and out of every road as soon as it falls, if possible. Now, as to wheel tires, let me remind you that you said a little while ago that a road was good enough for your purpose whenever the mud would roll and pack under the wheel; and by this I understand that you look upon your wheel as a roller. So it is. Every road becomes smooth by the application of a roller, and this smoothing process is hastened or retarded by the quality of the roller itself. If you have a wheel tire 1½ in. wide, like those upon your farm wagon, every time you go down the road with a ton of produce, your wagon wheels sink into the soft mud, form ruts, and tend to keep the road in a rough condition. Your 1½ 'roller' will not profitably exert its rolling qualities until the mud becomes nearly dry. A wider wheel tire would serve your purpose much better; and if the farmers of your county would use wheel tires 3 or 4 in. wide, as are used abroad, your dirt road would be rolled into passable condition in half the time that is now required to accomplish this result.

"Next to water, nothing is so destructive of a good road surface as a heavy vehicle running on narrow wheels. It has been proven over and over again that wheels with 4½ in. tires cause only one-half the wear on the road that results from the use of

wheels with 2½-in. tires. It used to be the rule in England to make the tire 1 in. wide for every 500 lbs. of load or vehicle—that is, if the vehicle and load weighed two tons, 4-in. tires would be used; but it was not found profitable to increase the width much beyond 4½ in., except in cases where wagons were used without springs, when they were sometimes made as much as 6 in. in width."

A Large Wooden Wheel.—Our readers will recall the bursting of the 30-ft. fly wheel at the Amoskeag Mills, Manchester, N. H., last fall, full accounts of which were published at the



A LARGE FLY-WHEEL WITH WOODEN RIM.

time. This wheel has been replaced by the one we here illustrate, which is probably the largest wooden-rimmed wheel in the world. It was designed by the superintendent of the mills, Charles H. Manning, and was built in their own shops. This wheel is 30 ft. in diameter, 108½ in. face, 12 in. thickness of rim, and weighs 104,000 lbs. There are two sets of iron hubs and arms, each hub being made in two parts, 7¾ ft. in diameter, 28 in. in length, and 20 in. face. The arms, of which there are 12 in each set, are circular in section, 8¾ in. in diameter at the large end and 6 in. at the small end, and are formed with projecting webs, as shown. At their outer ends are plates 20 × 24 in., which are bolted to the rim by eight bolts 1 in. in diameter. Each arm is secured to the hub by four bolts 1¾ in. in diameter. The rim is made up of 44 rings of Western ash, each ring being in 12 sections, each of which is secured by 16 lag screws. Between each set of arms there are four ¾-in. bolts extending through the rim from side to side. The cranks and connecting rods are balanced by plugs placed in the ends of the hollow spokes opposite the cranks. This work was done so well that the wheel has been run up to a speed of 76 revolutions per minute without showing the least indication of distortion. To form the rim, 20,000 ft. of ash were used, and 18,000 4 × $\frac{7}{16}$ in. lag screws. The segments are attached to each other with glue and lag screws and by the through bolts. As a further precaution, narrow openings were left between the ends of the segments, into which were driven well-fitted wedges soaked in boiling glue. In building the wheel, the first hub and its arms were put in place, revolved, and a score mark made on the ends of the arms. In line with this score the 12 sections of ash were bolted, the joints breaking over the ends of the arms. The next ring of ash was glued and lag-screwed to this. This was continued until the other set of arms was reached. Each ring was finished before starting the next. The whole pulley was turned while in place. The wheel is driven by engines having a diameter of cylinders of 36 in., stroke of 6 ft., and is intended to be run at a speed of 61 revolutions.

We may add that Mr. Manning is now building another fly-wheel having unusual features. The center and arms will be of cast iron, and the rim, 14 ft. in diameter, 30 in. face, and 12 in. thick, will be composed of 24-in. plates of ¼-in. mild steel, riveted through and through.—*Iron Age.*

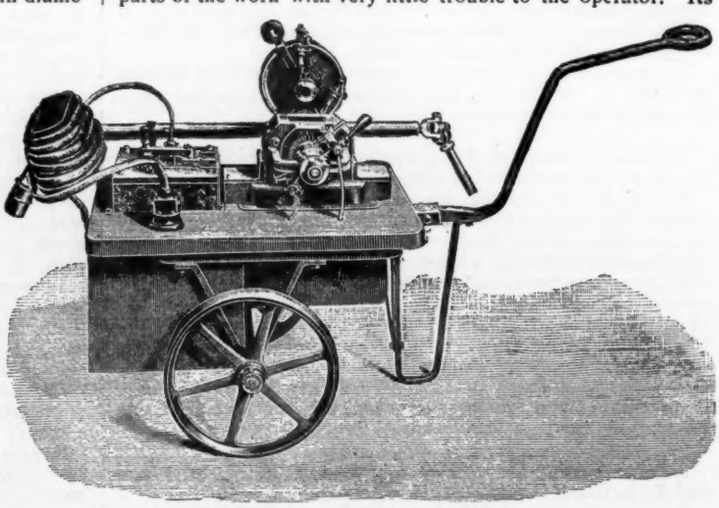
Steamship Companies of the World.—According to the statements of the French *Bureau Veritas*, the ten leading steamship companies of the world, arranged in the order of tonnage owned, are as follows:

	No. of Steamers.	Total Tonnage.	Average Tonnage.
1. Norddeutscher Lloyd	66	221,603	3,358
2. British India	91	199,096	2,188
3. Messageries Maritimes	62	102,631	3,107
4. Peninsular and Oriental	48	187,684	3,910
5. Cie Generale Transatlantique	64	165,035	2,588
6. Florio-Rubattino	105	161,687	1,540
7. Wilson Line	84	147,162	1,752
8. Hamburg-American Co	44	136,659	3,106
9. Allan Line	42	130,156	3,077
10. Austrian Lloyd	76	123,565	1,626

The same authority gives the total number of steamship companies of the world as 161, excluding those of merely local importance. The four leading nations, as far as the number of companies owned, are: England, 64; France, 33; United States, 15; Germany, 12.

A Portable Electric Drill.—The accompanying illustration shows a portable drill operated by an electric motor, built by the Allgemeine Elektricitats Werke, of Berlin. The drill is carried upon a small truck, on which also are placed the motor and rheostat. The connection with the dynamo from which the power is derived is by a flexible cable, which is attached to the motor, and which is shown coiled up upon the truck. The shaft of the drill is connected to the motor shaft by a universal joint, so that it can be operated at any angle. The feed is regulated by a hand wheel. In the tool shown in the engraving the motor can be run up to 1 H.P.; it can be worked with 60 volts and 17 amperes, or with 105 volts and 10 amperes, as required. Its speed is about 1,700 revolutions, and it can be regulated by adjusting the rheostat. The speed of the drill shaft can be varied according to the diameter of the holes to be drilled, and the shaft is furnished with three different connections by which the speed can be varied from 65 to 195 revolutions. The connection is so arranged that in case of an improper regulation of the feed, there would be no danger of breakage, as the connection is not rigid, but is made by a small counterweight which is seen above the machine.

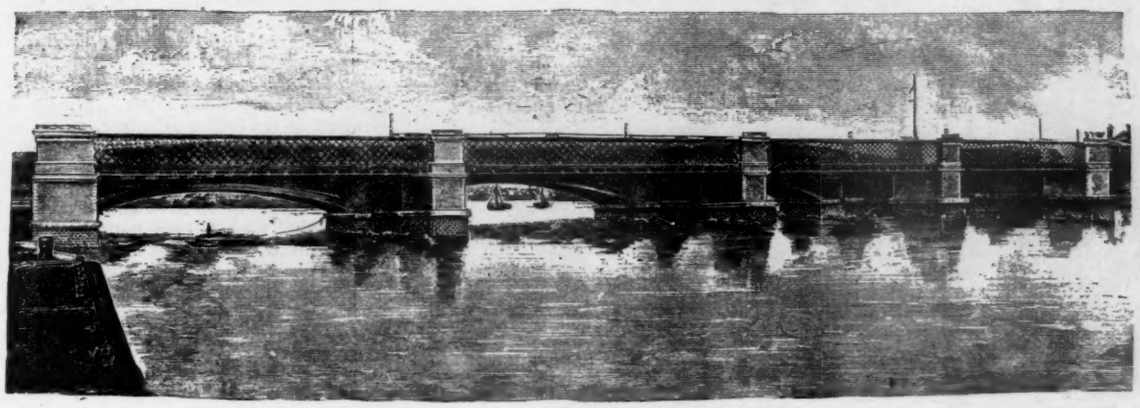
With a length of about 30 ft. of cable considerable latitude of movement is permitted; and the drill can be taken to different parts of the work with very little trouble to the operator. Its



PORTABLE ELECTRIC DRILL.

total weight, including that of the cable, is about 350 lbs. Drills similar to this have been found very useful in locomotive shops and in shipyards, and a number have already been manufactured and put in use. It would seem, however, as if in many cases a portable stand furnished with handles for lifting would be more convenient than the carriage shown.

A New English Bridge.—The accompanying engraving, from *Industries*, shows a bridge recently erected for the Southeastern Railway, of England, by the Horsley Company, of Tipton. The bridge crosses the River Medway, and has been built with the view of connecting Chatham with the above-mentioned company's line. The viaduct runs parallel with that owned by the London, Chatham & Dover Company, and is 670 ft. long, with four spans ranging from 120 ft. to 170 ft. It carries two sets of rails, and has outside lattice girders. The most interesting feature of the work, however, is the arrangement of the



MEDWAY BRIDGE, SOUTHEASTERN RAILWAY OF ENGLAND.

cylinders for carrying the piers. These are of the twin-type, representing in plan the figure 8, projecting down below high-water level a distance of 60 ft., and bedding in solid chalk. The superintending engineer of the work—Mr. Francis Brady—in adopting this form of cylinders had in view the attainment of the maximum of strength with the minimum of material. The cylinders are of cast iron, 13 ft. diameter and 1 in. thick, and filled in with cement concrete. The piers are 16 ft. wide, and are constructed of brickwork. The bridge has a clear headway above high water of 20 ft. 6 in. Its total cost was about $350,000.

Merchant Ships of the World.—According to the tables of the French *Bureau Véritas*, the merchant shipping of the world includes 43 514 vessels, of which 33,876, with a tonnage of 10,540,051 tons, are sailing ships, and 9,638, of 12,825,709 tons, are steamers. The average tonnage of the sailing ships is, therefore, 311 tons; and of the steamers 1,331 tons. This, it must be understood, includes sea-going vessels only, boats and vessels engaged in inland navigation, whatever their size, not being counted.

The steamships of the different nations are as follows:

Country.	No.	Tonnage.	Country.	No.	Tonnage.
Great Britain.	5,312	8,043,872	Russia.	230	177,753
Germany.....	689	930,754	Denmark....	197	154,497
France.....	471	805,983	Austria.....	111	149,447
United States.....	419	533,333	Japan	147	123,279
Spain.....	350	423,627	Belgium.	55	98,046
Sweden & Norway..	774	417,065	Brazil.	129	75,970
Italy.	200	294,705	Greece.....	68	70,435
Holland.....	164	220,014	Portugal.....	41	49,364

It will be seen that, according to this statement, Great Britain owns 55 per cent. in number and 63 per cent. in tonnage of the steam merchant marine on the high seas. The ownership of the United States is 4¼ per cent. of the total number and 4⅞ per cent. of the total tonnage.

Tunnel Ventilation.—The accompanying engraving, from *Industries*, shows a method of exhausting smoke from locomotives in tunnels, which has recently been patented in England by Mr. C. Anderson, of Leeds. The object of the invention is the purification of the atmosphere in underground railroads and tunnels by diverting the products of combustion given off from the locomotive, and carrying them through a communicating pipe to a flue in the permanent way. From this flue they are extracted in any suitable manner. Referring to the illustrations, fig. 1 shows a side elevation of a locomotive fitted with the necessary appliance; fig. 2 shows an enlarged section of the sliding-box fitted on the engine, and fig. 3 is a section of a portion of the flue in the permanent way showing a method of fitting the air valve. Briefly, the apparatus consists of a pipe, *C*, fitted into the lower end of the smoke-box, and having its lower end passing through a stuffing-box and fixed in the sliding-box *G*, which slides upon the suction flue *H* fixed between the rails. Dampers *D* and *F* are provided for opening and closing the funnel and the pipe *C* respectively, while a screen, *E*, is provided for preventing cinders from finding their way into the pipe *C*. The sliding-box *G*, of considerable length, is formed of sheet-metal and angle iron riveted together in such a manner that when it comes into contact with the air valves in the flue the valves will be opened without shock. The valves *M* in the flue are arranged at such a distance apart that there will always be one or two of them simultaneously held open by the action of the sliding-box *H*. To prevent damage to the apparatus arising from sudden shocks or oscillations, suitable brackets *K* and

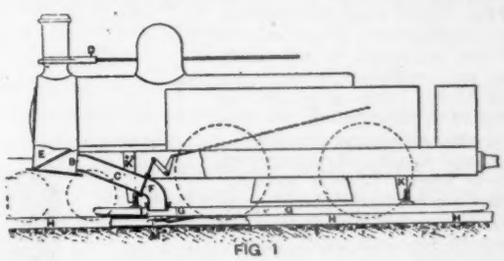


FIG. 1

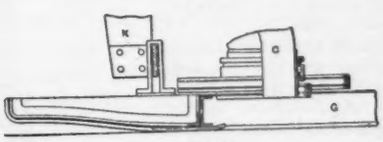


FIG. 2

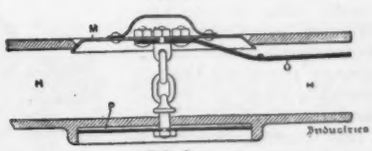


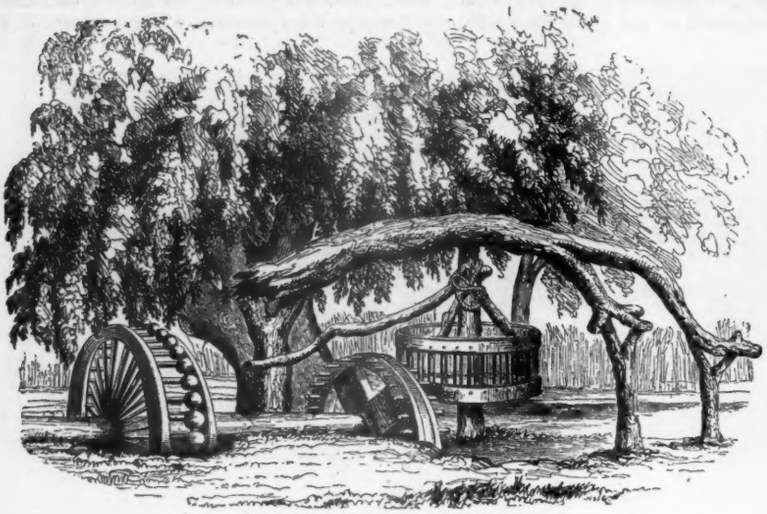
FIG 3

PLAN FOR VENTILATING TUNNELS.

cross-bars are provided. The action of the valve *M* and slider *G* will be easily followed from figs. 2 and 3. The valve *M* is held up against its seat by a spring, *O*, until the slider comes into contact with and depresses it. After the latter has passed the valve again rises, but is prevented from rising too violently by an air-cushioning appliance, *P*, fitted below the flue. Other forms of air cushion and other joints for the flue can be used.

The Persian Wheel.—According to a writer of nearly a century back, this machine for raising water is composed of one

horizontal and two vertical wheels, the former turning upon a pivot, the spokes of which catch those of one of the vertical projecting through the fellies, and turn it round. From the nave of this last runs a beam about 8 ft. long, attaching itself to the second vertical wheel, which rests upon two beams placed across the diameter of the well, and working between them. To this second vertical wheel thick ropes are attached, upon which are tightly fastened a number of small earthen pots, like



PERSIAN IRRIGATION WHEEL.

the steps of a ladder, reaching on each side from the top of the wheel to the water. These pots successively dipping in are brought up full, and empty their contents into a trough on reaching the apex of the wheel. They thus produce a continued stream which is conveyed to the neighboring fields. Two bullocks, driven by a boy, passing under the beam which supports the machine, turn the horizontal wheel by a shaft to which the cattle are yoked. This method is said to be able to water four bigahs a day per machine.

The arrangement described, as might be expected, is extremely clumsy and inefficient, a large proportion of the power employed being wasted in overcoming the friction of the shaft in the ground.

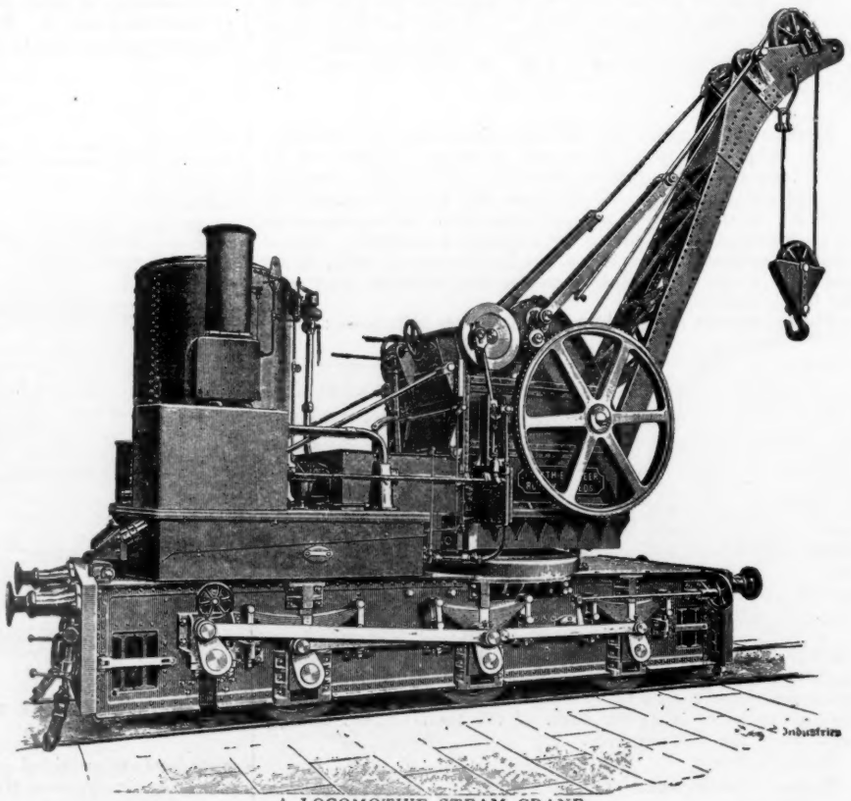
The usual number of earthen pots on these wheels is from 40 to 60 and they are generally placed quite close to each other, and as they are secured to the well ropes merely by a piece of string the breakage is comparatively great.

A vast improvement on this clumsy and primitive machine is the double or improved Persian wheel, which is an improvement introduced by English engineers on the primitive native machine, which, with the same labor of one man and two bullocks, gives almost exactly treble the result of the other.

The double or improved Persian wheel is generally employed in the military cantonments of the Upper Provinces for raising water for lavatories, swimming baths, and irrigation of the soldiers' gardens, and is admirably suited to the said purposes. The pity is that no one ever seems to have thought of providing the village cultivator with this greatly improved machine, and yet thousands of rupees are advanced yearly by collectors and deputy commissioners for the construction of wells.

Careful experiments, conducted at Roorkee some years ago, conclusively establish that for the irrigation of high lands, which are always to be encountered at heads of canals for distances varying from 12 to 30 miles to the head of irrigation, that is the level at which the canal water would flow on the natural surface, that the improved Persian wheel would be a cheap and efficient machine for irrigation of gardens, plantations, nurseries of young trees, and purposes of general cultivation.—*Indian Engineering.*

A Locomotive Steam Crane.—The engraving given herewith represents a general view of a 16-ton locomotive steam permanent way traveling crane constructed by Mr. T. Smith, of Rodley, near Leeds. The engines for operating the crane consist of a pair of the vertical type, with cylinders 8½ in. diameter and 12 in. stroke. These receive steam from a Nicholson type of boiler, 7 ft. 6 in. high and 4 ft. 6 in. diameter, with a large combustion chamber over the fire-box, and Galloway tubes. The jib is constructed on the lattice principle, with a curved head, to allow of heavy loads being dealt with. The crab sides are of mild steel plates, and are firmly secured to the top and bottom swivels. The latter have anti-friction rollers for running on a turned path to reduce the stress caused by the load on the central column. The hoisting motion is of double-purchase spur-gearing controlled by a clutch and lever, and powerful friction brake. A feed pump, injector, and tank are provided for supplying the feed water. The carriage is propelled by bevel wheels gearing with the engine shaft by means of spur and miter wheels, and driving the transverse shaft under the carriage, on which there are two cranks connected up by coupling rods and cranks to the traveling wheels of the crane. The frame of the latter is of mild steel plates and angles, and is mounted on six traveling wheels 3 ft. diameter, with cast-iron centers and steel tires shrunk and riveted on, and the axles are of steel. The whole superstructure radiates on a strong steel central pillar, accurately fitting a massive cast-iron base-plate,



A LOCOMOTIVE STEAM CRANE.

turned on the top to carry the roller path and internal wheel for revolving the crane. The various parts are easy of access for adjustment and similar purposes, and the whole of the movements are within easy reach and control of one attendant. The total weight of the crane is about 50 tons.—*Industries, London.*